DOCUMENT RESUME

ED 226 128		CE 034 851

TITLE	Statewide Conference on High Technology. Proceedings (Austin, Texas, October 7-8, 1982).
INSTITUTION	Texas Advisory Council for Technical - Vocational Education, Austin.; Texas Education Agency, Austin.
PUB DATE	Jan 83
NOTE	95p.
PUB TYPE	Collected Works - Conference Proceedings (021) -- Viewpoints (120)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Aerospace Industry; Biomedicine; Communications; *Computer Oriented Programs; Computers; Computer Science Education; Data Processing; Electronics; Employment Projections; Energy Occupations; Human Factors Engineering; *Industry; Information Dissemination; Information Processing; *Labor Force Development; Labor Needs; Management Information Systems; Medical Services; Postsecondary Education; *School Role; Secondary Education; *Technological Advancement; Technology; *Vocational Education; Word Processing
IDENTIFIERS	Computer Assisted Design; Computer Assisted Manufacturing; Robotics

ABSTRACT

These proceedings contain 11 papers that focus on how education must change what and how it teaches to keep up with the technological revolution. The presentations address the need for vocational education to produce students with skills in electronics and data communications (including computer-to-computer transmission); office systems and management of information; computer-aided design and manufacturing; robotics (including definition, need, technologies involved, major applications, and required skills); private sector initiatives to deal with social or economic problems; the role of vocational education in meeting the technical manpower needs of the energy industry; the need for workers with skills in biomedical engineering--both clinical engineering and bioengineering; the need for workers in the aerospace industry with skills in computer software, computer systems operations and maintenance of computer systems, software, and machines; high technological instructional options, especially industry/education cooperation; implications of high technology for education; and the need for the frequent re-education of workers and teachers caused by technological change. A final section provides comments from leaders in industry, government, and education regarding high technology, education, and the economy. (YLB)

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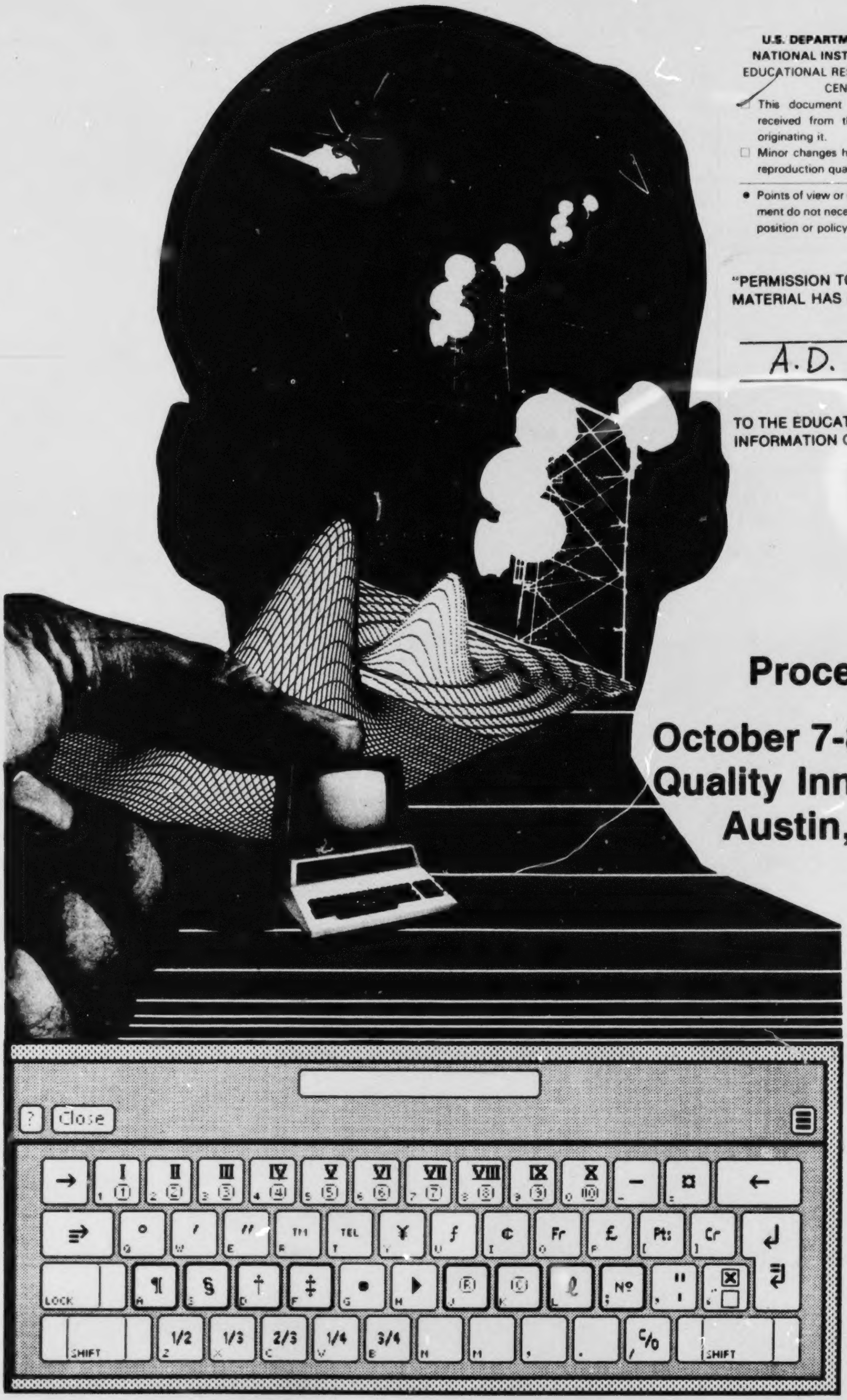

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Proceedings

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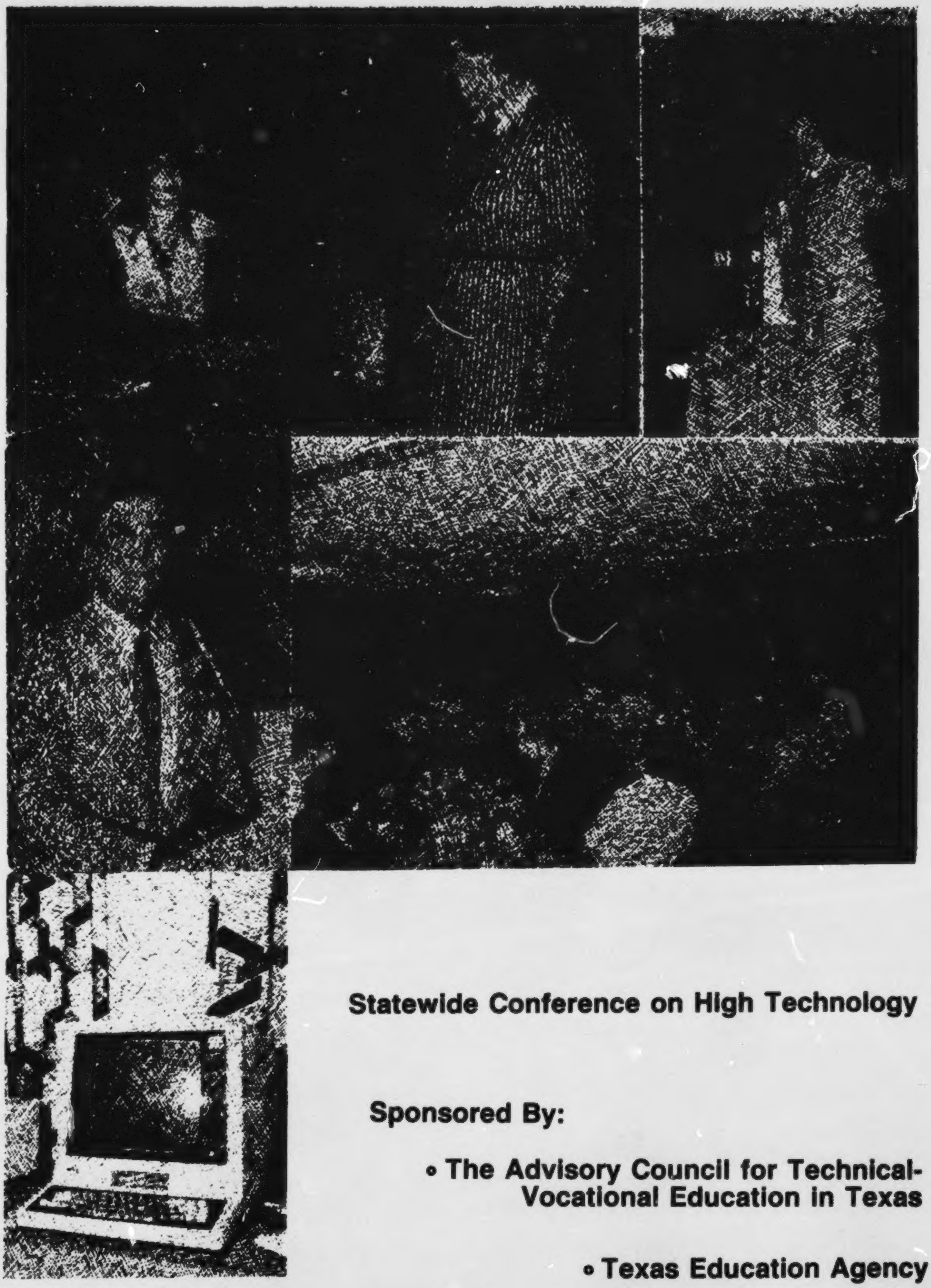

Statewide Conference on High Technology

Sponsored By:

- **The Advisory Council for Technical-Vocational Education in Texas**
- **Texas Education Agency**

January 1983

The Advisory Council for Technical-Vocational Education
in Texas

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Acknowledgements

A special thanks is extended to the Texas Education Agency and Austin Community College for the production work done in connection with the conference and to Raymer Educational Media, Inc., Wimberly, who sponsored the coffee breaks.

Introduction

"High technology" is the buzz phrase of the 1980s. Everyone is talking about it, from assembly line workers to corporation executives, from technicians to educators, from government officials to lawmakers.

Thomas Miller, a vice president for the Minneapolis based Control Data Corporation, puts high technology in its proper perspective with the comment, "the five-ton computer of the 1950s is now the size of a wristwatch."

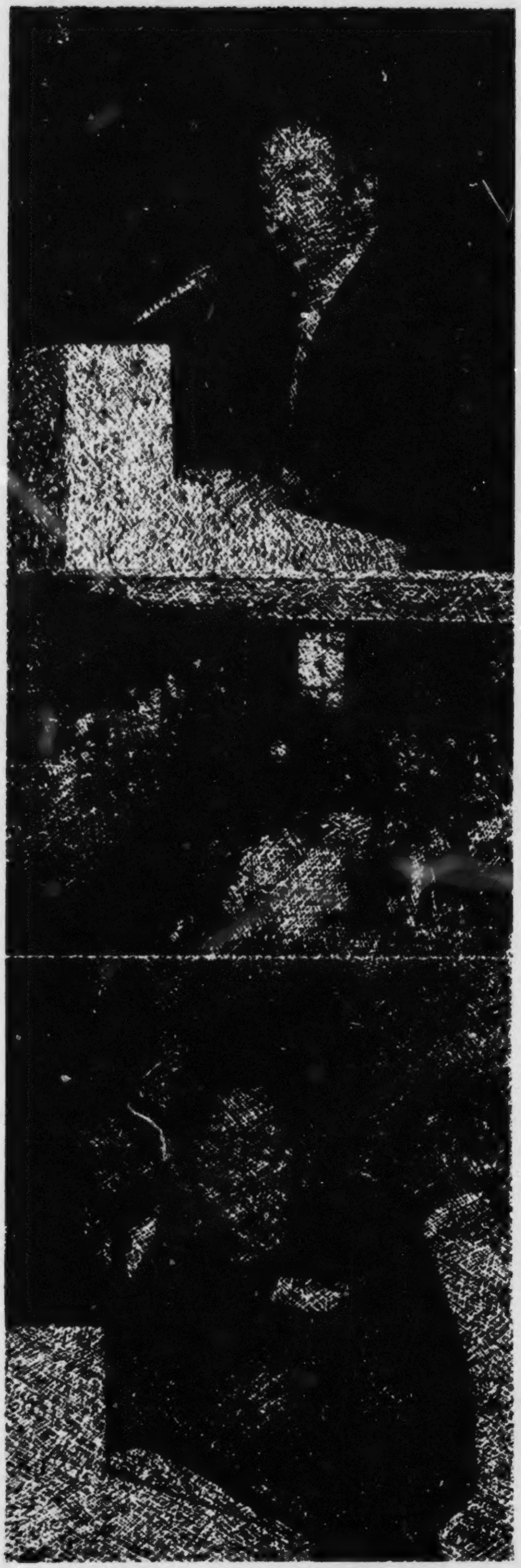
On October 7-8, 1982, the Advisory Council for Technical Vocational Education in Texas and the Texas Education Agency sponsored a Statewide Conference on High Technology.

Nearly 400 individuals from accross Texas heard industry leaders stress that education must change both what and how it teaches to keep up with the technological revolution this country and state are undergoing.

"The future is now," says Tom Hall, a vice president with Bausch & Lomb, Inc., who was one of the conference speakers. "It's not five years from now or 10 years from now. You cannot ignore it. It's not going to go away."

The high technology conference and this proceedings are for the benefit of educators and policymakers who must plan and implement programs to meet the needs of our citizens and economy.

--Robert D. Hunter, Chairperson
The Advisory Council for
Technical-Vocational
Education in Texas



High Technology At Work

Electronics, computers, word processors, and robotics are elements of high technology.

High technology is at work revolutionizing communications and marketing, design and manufacturing, energy development and health care, aerospace and national defense.

High technology is at work impacting on the types of jobs that are available, the performance of jobs, the ways people are educated, the programs to be offered and skills to be taught.

High technology is at work changing the home, the way we entertain ourselves, and the way we care for ourselves.

High technology is at work, necessitating closer industry and education ties as we work for a better tomorrow...today.

--Slide Presentation Script
Opening General Session

HIGHLIGHTS
STATEWIDE CONFERENCE ON HIGH TECHNOLOGY

The following are highlights of the comments made by the speakers at the high technology conference:

"...hardly any facet of our lives is not being impacted by electronics -- from video games to robots to cameras to missiles to calculators..." "During the 1980s, the demand for electronic engineers and technicians will increase about 200 percent."

--Ralph Dosher, Texas Instruments

"The office of tomorrow will allow you to handle dictation, typing, printing, storing and retrieving on one device such as a word processor or a computer."

--Mike Jordan, IBM

"...the future is now. It's not five years from now or 10 years from now. You cannot ignore it. It's not going to go away. In the computer aided design and manufacturing industry, we need to have the students coming out with a basic background in math, science, physics, chemistry, analytical geometry, and computer programming." "...there are four times as many non-degreed people (technicians) in an engineering department as degreed people."

--Tom Hall, Bausch & Lomb

"The driving force behind the increasing use of robots is the intelligence capability of a computer, and its being able to communicate with the human effectively..." "Repetitiveness by a human is on its way out..." "It's true that they are displacing workers. However, robots are also creating jobs."

--Rick Button, Texas Instruments

"Private sector initiatives offer us an opportunity to deal with a broad range of problems at a fraction of the cost and with far greater precision than you will ever get out of Washington, D.C. Private service today is a $150 billion annual enterprise, outstripping the combined 1982 budgets of eight cabinets of the U.S. Government. More than 84 million Americans volunteered for such work in 1980."

--Rob Mosbacher, Mosbacher Production Company

"Advances in this high technology in the energy field center on basically computers and instrumentation..." "We at Shell encourage you to keep up the good work in teaching your students the basics in math and in the sciences, and add to that the basics of the state-of-the-art in computer software."

--Mike Papadopoulos, Shell Development Company

"Health care, especially biomedical engineering, is a growing area in our society..." "Through the use of technology, we have people that are surviving accidents and diseases that would have been fatal even a decade ago. There is a growing need for people that are familiar with electronic and mechanical technology as well as computer applications in the medical arena."

--Tom Krouskop, Baylor College Of Medicine

"The aerospace industry is going to need workers...with specialized skills in computer software and computer systems operations...who have skills in both assembly/machining operations and maintenance people to maintain the computer systems and software, and machines."

--Frank Hurley, General Dynamics

"Education can wait no longer to accept the challenge of the work place. We must not wait to see what next year's technology will look like. We cannot wait for a new generation of computer or teaching device. No, the demand for high technology in education is moving so fast that we cannot afford to wait."

--Cecil Groves, Austin Community College

"I asked the vice president of a Dallas based telephone communications firm, which does $100 million plus business each year, where his company hurts the most with regard to workers. He said 'technicians.' 'We can't get enough.' That firm, which employs 800 workers, did not exist three years ago."

--Gene Bottoms, American Vocational Association

"The one thing I've heard over and over again at this conference is change -- immediate and continued change -- necessitating the frequent re-education of not only workers but also the people who are going to be the teachers..." "For the people in the high technology industries, tomorrow happened the day before yesterday."

--Bevington Reed (Retired), Coordinating Board, Texas College and University System.

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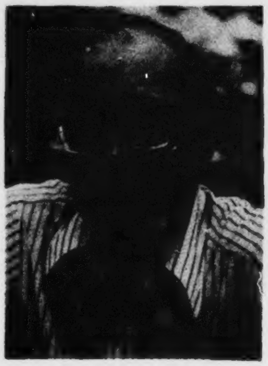
VOCATIONAL EDUCATION FOR THE ELECTRONICS/COMMUNICATION INDUSTRY

BY RALPH T. DOSHER, JR.*

TEXAS INSTRUMENTS



Electronic mail is not something in the future. In many companies there are computer terminals throughout their plants and even in their international plants. At TI we can and do communicate with Japan and Europe as easily as we do the office down the hall. Almost all internal TI mail is delivered (worldwide) electronically.

Electronic Communications

Electronic mail is made possible by advances in data communications. But data communications (which also includes computer-to-computer transmission) is just one segment of the electronic communication industry. This industry is as old as electronics, but with the introduction of solid state electronics it has changed radically in the last 10 to 15 years. The largest segment of the market is switching systems. These systems have changed over the years from manual operation to electromechanical relays to all electronic. Subscriber apparatus (mostly telephones) is the fastest growing segment because it is in the process of changing from rotary dial phones to touch-tone electronic phones. But data communications is just beginning and will have its major impact in the future when communication satellite, electro-optics, voice recognition/synthesis, and new computer technology begin influencing performance and cost.

Electronics Revolution

The communications industry is but one industry benefiting from the electronics revolution. In fact, hardly any facet of our lives is not being impacted by electronics--from video games to robots to cameras to missiles to calculators. What caused this revolution? What can we expect in the future? How should Voc-Ed participate?

Back in 1974, TI introduced a handheld scientific calculator. It had 154 parts, 71 of which were electronic. Two years later the number of parts was reduced to 94, of which 14 were electronic. A couple of years after that, total parts count was down to 16 with only two electronic parts--the display and the integrated circuit. Not just an integrated circuit (the original calculator had five integrated circuits), but a complete computer on a single semiconductor chip. During this period the price of the calculator declined from $300 to $30 with no reduction in performance. The ability to put more functions (as in a complete computer) on a single chip of silicon (the semiconductor material) is the key to the electronics revolution.

---

*Ralph T. Dosher, Jr., is Manager, Training and Education, Texas Instruments Incorporated, Dallas, Texas.

Active Element Groups (AEGs)

Computer functions are basically logic and memory. The group of electronic circuit elements associated with a logic or memory function is called an active element group or AEG. As more AEGs are integrated on a single chip the cost per AEG declines. Twenty years ago the cost per AEG was $10. Today it is about 1/10 cent. By the turn of the century it will be about a millicent or 100,000 AEG per dollar. The trend in putting more and more AEGs on a chip has been dramatic. Before the invention of the transistor (solid state electronics), a vacuum tube AEG occupied about four square inches. When the transistor came along, the AEG area was reduced to about 3/4 of a square inch. The early integrated circuits reduced the size to 2 1/2 millionths of a square inch. Today an AEG occupies less than 1/2 millionth of a square inch.

The number of AEGs per chip (a single package) is a measure of the integration level. These levels are given names such as SSI for small scale integration, MSI for medium scale integration, LSI for large scale integration and VLSI for very large scale integration. VLSI represents over 100,000 AEGs per chip. Microcomputers are usually LSI and VLSI. So the more AEGs per chip the lower the cost of microcomputers and the many products that utilize microcomputers. To produce more AEGs per chip requires very narrow line widths of material that form the AEG. The total circuit pattern of lines forming an AEG and its interconnections is called the geometry of the circuit. Thus, the geometry of VLSI must be very dense compared to the geometry of SSI. Line widths of about one micron are required for VLSI. (The diameter of a human hair is 75 microns.) If the geometry of SSI were compared to the "geometry" of a neighborhood in Dallas, Texas, and the geometry remained constant, than a chip of MSI would be equivalent to the Dallas-Ft. Worth complex and a chip of VLSI would be equivalent to the whole southwest. In a few years when submicron geometry is available, the single chip equivalent would be the whole North American continent.

Design And Manufacturing

Such complexity requires complex design and manufacturing. The manufacturing process is a photographic and chemical process. It starts with a slice of silicon about four inches in diameter. A mask, or negative, of a circuit pattern for 200 to 300 identical chips is projected on the emulsion coated silicon slice. Complete circuits or microcomputers are formed by repeated exposures through different masks, each mask representing different elements and connections of the completed circuit. After each exposure, the exposed parts of the silicon are etched away, and implanted with various ions in a diffusion furnace and/or metal plated to change the conducting paths generated by the mask exposure. Depending on the complexity, the exposure-etch-diffusion process is repeated a number of times. Also, the illuminating source will vary depending on the required geometry (visible light waves may be too long to provide the required resolution and electron beams become necessary).

Both the manufacturing and design process are so complex, computerized automation is necessary. With the very fine geometries required manufacturing has to be carried out in extremely clean environments, more so than an operating room in a hospital. In many operations robots are required for precise control and/or safety. This is the high technology that will put 400,000 AEGs in your home and 100,000 in your car by the end of the decade. Will we have the trained people to continue the electronics revolution?

Industry Work Force Requirements

During the 1980's the number of high school graduates will decline about 19 percent. Yet the demand for electronic engineers and technicians will increase about 200 percent! Most of this demand will result from the computerization of society made possible by VLSI technology. Computer literacy will be required by factory, office, and field workers. Conventional drafting will all but disappear in a few years--replaced by computer aided design. The traditional machinist that was essential to the smoke stack industries must now have skills to operate computer controlled machines and robots. Steel mill, oil refinery, chemical plant operators are rapidly becoming "computer operators." Office workers have replaced their typewriters with computer word processors. Even education is beginning to use computer assisted instruction. All of these computer applications will require technicians to build, program and service the equipment. In fact, the demand for programming, or software skills, will be far greater than hardware skills. In terms of total system cost, hardware constitutes only 10 to 20 percent while software costs are 80 to 90 percent.

To meet these needs industry expects high schools and post secondary schools to:

1. produce students capable of obtaining an engineering or computer science degree, and/or

2. produce students with technical skills that can build, operate, program, or service the products of the electronics revolution.

This means students must have math and science skills. In Texas last year only about seven percent of all high school graduates had any math beyond the required first year algebra. Texas Instruments must hire the majority of its engineers and technicians from out of state. And we conduct classes in our plants to teach fourth and fifth grade math to workers unable to perform their job. They are all high school graduates. This has to change if students are going to find jobs and industry is going to fill its needs.

Industry/Education Linkages

We can no longer look to the government to solve these problems. Industry and education must work together to find solutions. For example, can education produce the necessary computer literacy to meet the industry needs spawned by the electronics revolution? It didn't thirty years ago when the computer age began. Industry had to educate its engineers, its manufacturing people, its salesmen, and its customers. Industry does not want this burden again. But we will work with education to meet the need.

Texas Instruments has over 200 employees that teach part time outside TI. Most of these teach in community colleges. With technology moving so fast, it is necessary that your teachers maintain competence and teach relevant technology. Industry can help you in this area.

As indicated, electronics technology has become a very complex process. The equipment to build a semiconductor design "laboratory" is so costly, maybe only one or two universities in the whole country can afford to have one. Why not use industry facilities as your laboratory? You would have to schedule your classes during off-shifts or weekends, but is that an issue compared to the payoff? TI already has such an arrangement with Texas A&M University. Students do the design at school; then they go to Dallas to produce the actual semiconductor chips. We have a similar CAD/CAM arrangement with Eastfield College.

Teaching students with up-to-date facilities is important; but these students are already enrolled in technology courses. What is more important is to get students enrolled in technology in the first place. This means exposure to technology. We currently have a career education thrust in Texas. Nothing could be more important. Too many students simply do not understand the opportunities in technology. There needs to be more tours of industry plants, special short courses, school presentations by industry people, one-on-one guidance, science fairs; anything that will be a "turn-on" for technology. Computers are now being used in many schools; but they need to be used in far greater numbers. This is a powerful tool that can aid vocational education more than any other means. It can be used to generate excitement for technology because it embodies the very technology that needs to be taught.

Joint industry-education programs for post secondary and high school students are essential. However, if the high school graduate does not have the necessary math and science skills, it will be very difficult to succeed in technology courses in college. The reason only seven percent of Texas high school graduates take any math beyond the required first year algebra is because they "learned" in the fourth grade math was hard and no fun. That perception has to change. It is not likely to change with the current shortage of math and science teachers. To help this situation a program has just started in Dallas to change this image of math. A different teaching methodology is used and industry provides many of the teachers.

Success Depends On Qualified Workers

So, for the electronics revolution to be successful industry needs qualified engineers and technicians. They will come from successful technology programs in the post secondary and senior colleges. Their students will come from high school graduates that have completed a full math and technology curriculum. And students who take these courses are the primary grade students that have a favorable image of math and technology. Finally, the whole process has to be closely tied to and supported by industry. We all have a responsibility in the struggle to maintain technology leadership and economic survival in spite of unfavorable demographic trends. The electronic revolution is going to make the next decade very exciting.

COMPUTERS/WORD PROCESSORS

BY MIKE JORDAN*

IBM

I welcome the chance to talk to educators. Several eons ago, I was an educator myself, teaching in the secondary schools.

My presentation is on OFFICE SYSTEMS. We'll look at what has happened in the past. We'll look at where office systems are likely to go. We'll look at what the computer revolution is doing to the everyday working environment, and how we can fit into that. We will look at some of the skills that are required.

Regardless of what industry in which a person works, whether it be manufacturing, medical, aerospace, engineering, etc., there are certain commonalities within all of those industries in terms of the focus of office procedures. There is a certain amount of management of information that has to be processed in any environment. That will be the focus of my presentation.

Office Systems--Past and Present

Office systems went for many years without very much change. The traditional office prior to the 1960s consisted of a mechanical typewriter, a telephone, a file cabinet, an adding machine, a secretary to take dictation, perhaps a dictating unit or belt, and, of course, people.

The so called modern office concept began with the 1960s. It still looked pretty much the same. The major differences were the arrival of electronic typewriters, magnetic cards for information storage, and the photocopier.

The photocopier is an interesting phenomenon in the office. Before it was invented, people didn't know they needed copiers. Everyone was quite happy with carbon paper. Now, however, the copier has been ubiquitous in most offices.

The 1970s brought the systems approach to the office. Arriving on the scene were the keyboard with display tube, magnetic disks for storing large amounts of information, and the high-speed/quality printer. There were still people, file cabinets, and lots of paper.

Things began to really happen during this period of time. Costs began to change. The cost of people is still going up at a steady spiral, but the cost of technologies is going down in price.

For example, the preceding speaker mentioned the pocket calculator. When the pocket calculator came out a decade or so ago, it cost several hundred dollars. Now, when you open a bank account, they give one to you. They just give it away.

---

* Mike Jordan is Senior Planning Manager, Product Development, IBM, Austin.

Information, Processing, Hardware

Let's talk about future office systems and their information requirements, processing requirements, and hardware configurations.

Information requirements relate to the written and spoken word, as well as pictorial and graphic images.

Processing involves absorbing information into our minds, as well as sending, storing, and retrieving.

Hardware configurations involve the equipment used to transmit, receive, process, store, and retrieve information.

You have, of course, text and audio to deal with each day. You also have images. Thirty percent of the information that crosses in front of your eyes in a given day is pictorial (i.e., graphics and photographs). The office system has to be able to deal with that type of information.

Then there is data with which to deal. Data, in its pure form, involves data processing -- crunching numbers, and getting reports out.

You have a variety of hardware configurations (equipment) that are used in dealing with information.

The electronic typewriter is the most common. It can be used by itself or as a part of optional communications and optional media.

Communications is one typewriter communicating electronically with another device somewhere else. Optional media means being able to store information on something other than paper so that you can update it or modify it very quickly without having to retype the whole thing.

The electronic typewriter, without memory or storage capabilities, is a "dumb work station." The trend is toward the "intelligent work station" (memory and storage capability), involving the word processor and computer.

Other hardware configurations in dealing with information include such devices as the printer and optical character readers. It is not necessary nor economically feasible to have a printer for every work station; thus, you will see several work stations sharing one printer.

Optical character recognition has not yet been perfected. More technological breakthroughs are needed in this area.

Work Stations

Within the office setting, you have both single and multiple work stations. The single station might involve simply an electronic typewriter that most of us are accustomed to using, or you might have a self-sustained word processor or computer.

The multiple work station concept involves several processors or computers attached electronically to each other (called a cluster) or being connected into a central memory or storage bank/file.

The personal computers (self-sustained) are really beginning to have a revolutionary affect on many of our kids. Six, seven, and eight year-old kids are already learning how to do programming.

The office system technology today, and most certainly in the future, affords a variety of specialized applications.

Through filing and retrievals, for example, real estate people are able to keep up on housing listings and contracts.

A lawyer can build a will easier. The lawyer can bring up standard contracts, taking a paragraph from here, a paragraph from there, put them all together, and create a standard will.

Specialized applications are good for the consumer. You can now get a will done for perhaps $50 or $100 instead of the $300 or $400 a few years ago when wills were written from scratch.

There is a trend emerging toward distributive processing, which leads to electronic mail. This involves establishing interface capabilities between two or more word processors or computers in one or more locations.

The office system objective, from the user's point of view, is to increase the productivity of people through the use of equipment. You spend a lot of money for people; thus, you want them to be more productive.

You want to be able to get more output from every dollar that you put into your business. You want faster access to information. You especially want a system that accommodates itself to your style of doing business.

Office Systems Factors

Let's talk about the office systems. There are a number of factors to consider. First, you have the management factor. You must have a commitment and willingness from management to help the work force understand that sophisticated office systems are not to replace them, but to enhance productivity and quality of work. Management must also commit itself to training programs which will produce the least amount of frustration and transition among its workers.

Secondly, you have environmental considerations. You must maximize energy conservation in the use of power. You must minimize the impact of noise, lighting and power usage on the workers in the office.

The processing of information is another factor. What good is a system if it doesn't do processing for you? That means it must be a tool for you, to help you deal with and handle information.

Then there is communications. We all deal with other people, and we tend to think better when we have interaction with other people. We can stir each other up and think better. Office systems should encourage communications and the exchange of information, rather than discourage it. It shouldn't make people work in their own little isolation cell.

Finally, there is the "real people aspect" to office systems. According to Department of Labor statistics, there are between 27 and 28 million executives, managers, administrators, and other professionals in the office. Their jobs are to evaluate information and make decisions.

Then we have administrative support personnel whose jobs are to help them get and process the information so that decisions can be made. There are only 9 million typists in the U.S. to support these professionals.

This imbalance between managers and support personnel means the old days of a manager or an office worker and a secretary sitting right outside the door are gone. The good old days are gone not only because of the imbalance, but also, because women are no longer satisfied just to sit and be a typist or to go and fetch coffee. Women want a challenging job.

Applications

Let's talk about some applications. I will discuss four, which are: text processing, information distribution, filing and retrieval, and conferencing.

Text processing means being able to input text into a computer or word processor. You can type it into the system, using a keyboard. You can revise it quickly and neatly. You can format it. You are then ready to output it, using a printer or some other means.

Text processing is the keystone to all the rest of the applications I am going to talk about. You have to be able to get information into and out of a system before you can do anything with it.

Information distribution means document distribution, or getting something from one point to another. The previous speaker called the process electronic mail. If you want five copies, push a button and tell the system to give you five copies. If you want a copy to go to five different people, tell the system the names of the people to receive copies. They'll all get a copy.

The office system should accommodate itself to audio support. By that, I mean being able to dictate letters or messages into a computer/word processing system using a microphone, or telling the system vocally to send a message/letter to someone else. In addition, these "verbal memos" should be able to be attached to conventional documents.

Why do we want electronic document distribution? Seventy-four percent of the elapsed time between you originating a letter and somebody else receiving it involves the U.S. mail. It only takes one percent of the elapsed time to originate a letter. Once a letter arrives at its destination, it gets bottlenecked in incoming and outgoing baskets within the office setting, involving even more wasted time. There is no guarantee that the letter won't get lost within the postal service.

Electronic distribution allows you to save time and guarantee delivery. It also reassures the sender that it got there.

Telecommunications is an up and coming field for the distribution of information, requiring people with specialized skills. In my opinion, it warrants being a separate and distinct area of study rather than including it under another field of study, such as computer science.

Filing and retrieval is another application in the office, involving information storage, information access, and records processing. Records processing means being able to take data, manipulate it, do something else with it.

The traditional filing and retrieval system involves typing something, such as a letter. It gets put in a folder, which gets put in a file cabinet. Sooner or later, somebody goes and looks for it. It is not particularly efficient, but it is the way we have been doing things for a long time.

Today, however, we are moving more and more toward the electronic filing and retrieval system. Such a system allows you to file all the information in your office on some type of magnetic media. This might be a large-capacity file or even floppy disks. You can program such a system to allow for easy storage and recall, using your very own filing terminology.

The last application I want to talk about is called conferencing. Conferencing means sharing data. We are conferencing right now. I am sharing data with you, using audio because you hear me. We are using image because you can see the pictures and graphics on the screen.

Traditional conferencing sometimes involves getting on an airplane and flying across the country and sitting around a conference table. An alternative to all that is electronic conferencing.

There are very practical applications for electronic conferencing. Those of you in a big school system often must attend a lot of meetings. It's the same way with IBM and Texas Instruments. We have buildings scattered around a large area. Electronic conferencing allows you to sit in your office and participate, for example, with a speaker telephone hook-up, in a meeting with people located in other buildings or at other locations around town.

Electronic conferencing is becoming quite sophisticated. Several vendors have developed an electronic blackboard. You can write on the blackboard at you location. People at other locations will be able to see what you wrote through electronic tie-ins between your board and theirs. This seems to have practical application for education.

All of these advanced applications have tangible productivity benefits. What that means is that a user can save money and can become more efficient.

The principal support terminal is probably the keystone of the office system. It will eventually probably have features like audio commands and automatic calendars. For example, you can enter in your daughter's birthday. When the day arrives, the system will give you little messages, telling you not to forget your daughter's birthday.

Message storage and forwarding might be another feature of the system. It will receive a message electronically. If I'm not there, I could tell the system I'm in somebody's office. The system stores the message and notifies the office down the hall that I have a message.

Teleconferencing, record processing, and an electronic mail box are all components of an intelligent work station. These intelligent work station components might all be connected to a storage and retrieval center, where you can file the equivalent of hundreds of thousands of pages of information. These intelligent work station systems can, and are, being interconnected to other systems in other buildings and cities.

Keep in mind that the principal support system allows you to handle text, process office information and data, and do reports.

Document distribution is handling the written and recorded word. It's having a switching system that enables you to distribute information to other places.

By the way, video and conferencing will not be television-type video. First of all, it is too expensive. Secondly, the technologies are not really very refined. Thirdly, you are interested in information, not what I look like. So you can have conferencing where you can accommodate video very easily (e.g. be able to view information and charts), clear across the country, but to achieve the real television type quality and sophistication, satellites are required to accommodate long distances. This is because television does not accommodate itself to the curvature of the earth; thus, is only practical for short distances.

Advancing Technologies

Let me say a word about advancing technologies. In the past, the problem with computers was that as you got more and more sophisticated, you had to throw out the old and bring in the new. We are moving in the direction of designing and structuring systems so that you can just add on features. We are talking about features that deal with input, processing, output, and storage.

For example, when we think of input, we automatically think of the keyboard. We're just now really advancing technologies to accommodate optical character recognition, and inputting information through audio (spoken word), and images (pictures).

The education system should teach people not only how to do computer programming, but to understand how systems are architected and how systems are designed.

Printers

Let's talk briefly about printers. There are two kinds of printers that come with office or data processing systems. One is engraved printing, which means a device, such as a daisy wheel, that actually slaps against the paper with some kind of force.

Matrix printing is the other system. It sprays the ink on the paper. It's a very fast process and of high quality.

There is another system being refined, which is called electrophotographic printing. It's a xerography process or laser printer. It's so fast and offers so much quality that it almost makes most other printers obsolete.

Display Screens

Let's talk about display screens. Displays are used for a variety of things, such as displaying text, or displaying images.

There are two kinds of displays (format and non-format). The format display shows you what the page is going to look like when it's finally printed out. It typically will have a scale line at the top and symbols to tell you where you are at any given time.

The non-format display is just a tool to the typist. It allows the operator to do a line at a time, back-up to correct mistakes, and then go on to the next line.

Storage

Let's talk about storage. Primary storage media today is paper. There is talk of the "paperless office," but paper is not going to go away. We will still have it and will need to store it.

This is not to say that video disks and micrographics (microfilm) are not playing larger roles in the storage of information, and will supplement and even lessen the volumes of paper.

Back in the 1960s, office systems had little reels of magnetic tape which didn't store very much information because people were not interested in using magnetic tape as a storage device. They just wanted it as an editing device.

Today, people want to store great volumes of information on some kind of magnetic media, and be able to retrieve it easily and quickly.

Why do we want to store so much information on magnetic media? A typical office memorandum has 2,000 characters on it and takes up 16,000 bits of information on a magnetic media. Relative to today's technologies, that's not much space. However, the same memo, if stored on image media (microfilm) takes 200,000 bits of information. To do a one-minute audio message takes nearly 700,000 bits of information. When you begin storing images and audio, you need tremendous storage capacity devices to accommodate them.

The office of tomorrow will allow you to handle dictation, typing, printing, storing and retrieving on one device such as a word processor or a computer.

When you stop and think about it, the basic elements of the office really haven't changed. There have been people, equipment, filing and retrieval devices.

Today, however, high technology has given people new career opportunities. They have new pizazz in their jobs because they have new ways of doing things and are able to do them more efficiently.

People like to feel more efficient. It makes us feel good. Therefore, we now have specialized equipment which can be oriented for specific skills and specific professions.

Then there's customized media storage, depending on the kind of information that is being stored. If you have a lot of numbers, then you want one thing. If you've got a lot of text you want something else. If you have a lot of graphics, or audio, you want something else.

Demands for Workers

Let's talk about the types of workers and skills that are needed. This is my point of view.

In the computer/word processor field, there is a demand for systems programmers. We need people to design computer programs and to design new systems.

We need applications programmers, which are people that take existing programming languages, such as basic, and develop applications for it (i.e., payroll, billing, inventory).

System maintenance personnel are in great demand. What happens when the system goes down? What happens when there's a bug in the program? Is it the program? Is it the hardware? Did someone pull the plug? That's system maintenance.

Hardware maintenance is another area in which workers are needed. We need people that can find out what's wrong with the hardware. Did the printer break? Did the display break?

Computer operators are needed. We need people who know how to turn it on, how to load a program, how to do troubleshooting.

Word processing specialists are in great demand. That sounds like just typing, but it's not. It's more than typing. It's being able to use a computer system in filing and retrieving and in handling certain office procedures, such as booking airline reservations, etc.

Communication specialists are in demand. We need people who can define what the requirements are for the office. What kind of wiring is needed? What kind of systems are needed? What kind of software should be provided? These people must also be able to install equipment and to train other people on how to use it.

Perhaps the most important worker in demand is the "human-factors" specialist, who is a person who is able to help design systems that are easily understood and used by the casual user (i.e., consumer).

I hope this has helped you understand the "new" office environment. Thank-you.

COMPUTER AIDED DESIGN
COMPUTER AIDED MANUFACTURING

BY TOM HALL*
BAUSCH & LOMB, INC.

There are two basic messages that will run throughout my talk. I want to underline them as I get started.

First, the future is now. It's not going to go away. There's a strong feeling to do that. Don't. It's a mistake.

What is CAD/CAM? It is just a means and a tool that allows us to design things faster, more efficiently, and to have them work better. It is something that has been used for about 10 years now, but it is becoming common in everyday design.

CAD/CAM is using computers to assist in the design of a product, to provide drawings of the product, to create instructions for numerically controlled milling machines, and to provide operator and service manuals for the products.

Design and Manufacturing

The first part of CAD/CAM is design. The second part is modeling.

After we've designed something, it usually doesn't work; thus, we try to build a model of it to test. You see a lot of ads on TV about car companies doing this.

CAD/CAM allows you to build a model in a computer rather than building an actual physical or iron model. It's a lot easier to drive a model down a rough road inside a computer than it is to actually build something out of iron and test it.

The nice thing about the computer is when you screw up, you can correct your mistakes in about 30 minutes. If you've really built a model, it may take several months to correct the mistakes.

After you've developed the model, you do analysis on it. The cost of a car basically depends on how much it weighs. You want to analyze every piece of the car to see where you can take iron out.

The next step in CAD is the computer aided drafting where you create the drawings for internal use and to also supply outside vendors.

Once you pass this stage, you're off into a CAM world, computer aided manufacturing. You plan the manufacturing processes to build the product.

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Computer Aided Manufacturing involves:

.design of the tooling to be used to build the product. For example, if you're using a lot of plastic, you need to create those plastic parts.

.numerical digital control, which is basically replacing the operator who cranked the handle and the lathes in the past.

.a filing system, which allows you to find those things that you've done previously and to easily look at them.

A filing system is not to be confused with design of the tooling. The computer allows you to follow the path the milling machine will take in cutting a tool before you actually start cutting metal. If you have made a mistake in design, you can correct it in the computer rather than busting up a $10,000 machine tool.

One of the nifty things about CAD is it allows you to do analysis that you didn't have the time, energy, or the manpower to do in the past. That is one of the key things that it's bringing to us.

CAD Applications

There are a lot of applications for CAD. For example, in the field of architecture, you can design a facility, lay it out, and show it to the people that are going to buy the facility before it is physically constructed. This can all be done in the computer without time-consuming models being developed.

Again, keep everything as soft as you can (in the computer) until you are sure it's right. Then build it.

Another application of CAD is in the fairly mundane areas. Everybody has seen plat layouts of plans for housing projects. You can take the surveyor's field notes and draw the plat plan directly, using the computer, without going through all the intermediate mind-moving calculations.

How about the use of CAD in the design of an airplane? There are several airplanes in existence today that would still be on the drawing boards for another two years if it wasn't for CAD. It allows us to structure and model.

The person who is the chief designer will typically come up with a gross outline of an airplane and say this is how I want the thing to basically look. These are its basic structures.

The chief designer will start handing the project off to other people. These people will be responsible for the nose, the winglets, the engine, the tail, etc. The computer is being used throughout the process. With its data base capabilities, the computer keeps track of what everybody's doing. The computer reduces the design cycle by as much as a factor of ten.

Design a Product Only Once

The CAD system, with its data base capabilities, means you only have to design a product once. You can make multiple copies or multiple changes from that design, but you only have to draw and design it once.

This is really one of the important parts of the CAD technique. It says you should only have to draw and design any one thing only once in your lifetime. If you've done it once, you should never have to do it again.

If you look at the typical breakdown of where time is spent in an engineering department, you tend to see that a significant portion of it is spent in drafting.

By the way, there are four times as many non-degreed people involved in an engineering operation as degreed people. In some cases, it may be as high as five to one.

Now I've noticed that some people feel that everybody working in these design departments either has a masters degree or a Ph.D. It isn't that way. There is no reason for it to be that way. It's a good argument that says one engineer to 10 non-degreed professionals working in that group.

Computer Aided Drafting

I want to focus on computer aided drafting. Our company is heavily involved in this. Drafting systems are a subset of computer aided design.

What does a drafting system do for you? It allows you to make quick, easy lettering. It eliminates repetitive work. It gives you overlay techniques.

Probably the most important thing about the system is that you can very easily make corrections when you foul up something.

You can do cross-hatching with the system for highly accurate drawings, but that tends to get a little bit more into the advertising side of the fun.

There is one theme that runs through here though. We are trying to take all the mind numbing, repetitive, non-thinking work and bury it in the processor. We want humans to be able to have more time to think and not just doing something repetitively that you can almost train monkeys to do.

It's planning systems like that. That's what we are always looking for. If you can get enough market volume in it, design things that do the repetitive, non-thinking job functions.

Let's take some examples. Anybody that's been involved in drafting has worked with plastic templates.

At Bausch & Lomb, we are taking the template items (symbols) and putting them up on a computer menu. Instead of drawing a symbol with a template and pencil, you touch a button and select that item.

We've put a little bit more sophistication in our computerized templates. For the architects, we have window patterns. For the logic designers, we have gates. For the mechanical designers, we have springs, screws, and screw heads.

In fact, our company, when it supplies a system, gives the buyer something like 10,000 different symbols that they can select just by the touch of a button.

There is an important side issue to this. The nice thing about the computerized template is that you can make the symbols the different sizes and rotations that you want. A plastic template may not be the size you want.

A system like this will provide the drafter with the tools where he/she can change the angles, the size, and the rotation. I might add that it can be done in 3-D.

We talked about the simple plastic templates. Consider this. The computerization allows you to have a symbol drawn as many times as you like at the push of the button. Gone is the pain of hand drawing something many, many times.

Again, the whole point is only do anything once in your lifetime. Let the computer do it after that.

Let's take lettering as another example. That's what just about flunked me out of engineering school. I hated Leroy pens. If I was going to punish somebody, I would make them draw with a Leroy pen for two years.

In the design of the computerized drafting system, one of the things we were sure going to do was get that Leroy pen out of peoples' hands, and let the processor do the work for them. The computer system can select any font. At last count, our system had 20 different fonts that were available.

You can tell the computer to print the letter slanted, large or small, vertical or horizontal, or have it squeezed in between two points.

It doesn't seem like much, but when you start thinking about people creating drawings, this is one area that eats up a lot of time.

Suppose I want to crosshatch (series of parallel lines that cross)? This is another one of the mind numbing tasks that you would like to have a computer do. It doesn't take a lot of creativity to draw straight lines for 30 minutes.

The computer allows you to do some pretty sophisticated line patterns. Again, the theme is take the mind numbing, tedious, repetitive work away from the human and put it in a processor. The computer doesn't care. It will work for hours and hours and not get in a sweat. People will go to smoking pot if they have to do it for hours on end.

Let's talk more about electronic overlay. That's a fancy phrase for saying you can build up a drawing in layers. You can put the base drawing on one layer, dimensions on another, text on another, plumbing on another, electrical on another, etc.

Why is this nice? If you're designing a building, you will typically have plumbing and electrical details, etc., scattered throughout the drawing. The electricians frankly do not care what the plumbers are doing. It's just confusing handing them all that extra nonsense.

When you create a drawing for the plumber, you tell the computer to leave out the electrical stuff. You give the plumber the layers involving plumbing and the basic information about the building.

The computer gives you a lot of options to select, enabling you to selectively supply information to the user.

Let's go back and look at the drafting system a little bit again. How does all this happen?

You have a digital TV whereby you can draw on and erase on. You have a digitizer which is really just an electronic drafting board. There is a terminal that allows you to give commands to the system, telling it what you want it to do. Finally, you have a plotter that takes over the Leroy ink type of operation.

Not to steal from the next presentation, but in effect the plotter becomes a robot. You think about it. You have taken and made a robot out of it and replaced the repetitive (robotic) actions of the human. Have we done the human disservice? I don't think so.

Let's look a little bit more at the interaction between the computer and humans. One of the things that we were concerned about in bringing our system on the market was how do we introduce it to humans so they can use it easily?

We provide a menu. Instead of having to remember a bunch of commands and how to do things, there is a menu that sort of guides you along the way.

An interesting thing about the menu is that no person or no customer that I know of needs to use the menu much after about six weeks. By that time, they have pretty well figured out how to do things that stick in their memory. They do everything from a keyboard.

If you did not have that menu to start off, you would be dead in the water. We would have violated one of the basic tenets of building systems like this. We would not have made the system user friendly. It's a buzz phrase, but it's an important buzz phrase. When you go into things like this, they need to be friendly.

Let's look a little closer at the plotter. When you use the template symbols repetitively and tack them together, there is a benefit to be derived that's a little bit less obvious. You can treat the collection as a whole template like item, and again only draw it once. You can retrieve it. In fact a good system like this will allow you to select anything you've previously done and use it as a part of another design.

Computer Aided Manufacturing

Let's go back and talk a little bit more about CAM, computer aided manufacturing.

After you have gone through all the nifty design stages, the next thing you have to do is to get your design to where it can be manufactured. That's where the CAM comes into play.

In CAM, you are really trying to replace the human operator who is running the lathe or the mill. There are a couple of reasons you want to replace the human element.

Humans are good, intellectually, but they are not very good in rope repetitive tasks. If you are making a hundred copies of a certain part, it is an odds on favorite, you are going to foul up one of them. If you can get a numerically controlled tool to make a certain part, it is going to make a hundred of them just like each other, if you designed it right in the first place.

In using CAM, what you will typically do is use a part programmer to define the tool paths. Then even before you start making the part, you'll look at it on a digital TV. You will actually look at the cutter paths. You want to make sure you're not colliding with another part of the machine, that you're making it right, and that sort of thing.

Once you have gone through it and made sure that you're making it right, then you can spawn off a numerically controlled program which will direct one of these automatic mills or automatic lathes. After you've created the program, you can then direct where you want it to go.

There are about 200,000-300,000 different types of numerically controlled gears; thus, you have to have the ability to point it at different numerically controlled machines easily and to speak the language of that machine.

Computergraphics

Let's take a few minutes and talk about computergraphics, which in itself, is the key to being able to do these sorts of things. It's the ability that allows you to communicate with a machine and not have you being pampered by the machine.

You see computergraphics a lot on commercial television. Sometimes you don't recognize it, but a lot of the ads and logo symbols are computer generated. For example, you can artificially create a real life scene without it having ever existed in real life.

As another example, computergraphics allows us to look at things and perceive informational content quickly. Pictures are worth a thousand words. We are trying to make a picture worth a billion words by employing color and getting the data content up quickly.

Affect on Education

How does all this affect you as educators? Well, I am going to walk the plank in saying how I believe it affects you. But in all honesty, I've been wrong a significant percentage of the time.

First, we need to have the students coming out with a basic background in math, science, physics, chemistry, analytical geometry, and computer programming. Please notice that I added something which a lot of people don't think is one of the basics, but it really is.

Computer programming is achieving the point of being just as important as math, science, analytical geometry, etc. If you can't give us the people with computer literacy, you set us back about 1 ½ to 2 years in working with them. It's just killing us.

Secondly, I am somewhat personally doubtful that we can get the people with the type of background needed for our type of industry prepared through our secondary schools. I think they probably have to come out of the post-secondary schools. There are some areas in servicing computers where I may be wrong.

I am scared to death, knowing and seeing the way technology is going, that if we are not careful, we are going to be in the same suit that Michigan is in right now. They have a whole bunch of people that are being replaced by machines.

If it can happen there, it could happen here if we cannot get the intellectual content of our kids up. A machinist per se is a dying art. A welder is a dying art. A straight electrician is a dying art. A secretary is a dying art.

You get too many kids educated in these areas, and in about 10 years from now, we could have a monstrous unemployment problem. We'll have to spend even more on retraining.

I'm guessing that as much as 50 percent of the training that will go on in our post-secondary schools will be retraining. They are certainly going to have to do it in Michigan and do it in a bloody big hurry because those jobs are never going to come back in the auto industries. Anybody who thinks they are is crazy. They are having robots to replace those people.

This is a scary thing. It's scary to us working in it. In fact, one of the things that I really got excited about in getting you all cornered in a room for 35 minutes was that I am from industry and you are educators. Usually it's engineers talking to engineers about this subject. Engineers can talk about it to each other until the world looks level, but until we start getting the message out to educators that the future is here now, we will never begin to have our needs met.

What I have shown you today is not the future. The future is going to be something even more radical than that.

We are evolving this stuff at such a rate that technology is forcing me to go back and retrain myself on regular two-year cycles. If I don't retrain, I've lost pace with what's going on. I'm dead in the water.

Back in the mid 1970s, people started looking at computers from a hobbyist standpoint. Someone very cleverly started stashing these personal computers in the public schools. Whoever did that may have saved the day five years back and certainly deserves a pat on the back for it. We are starting to see kids coming out with true computer literacy. We are seeing 18 and 19 year olds bumping 35 and 40 year olds out of jobs.

Assembly work, that we are all accustomed to seeing, may go on for five more years. There will be no increase in my view in the number of people doing assembly work in Texas in 10 years. It will be the absolute same number of bodies that we are seeing in this current time span.

In other words, I suspect we will take our production up by a factor of 10 or 20 without ever increasing the number of humans involved in this type of labor. A radical thought? Yes, it is a radical thought, but the technology is here to increase production without increasing people power.

The only thing that is hindering us from taking it even faster is getting the computer literate humans to push through and expand this revolution at the rate of 40 percent per year.

Type of Workers Needed

Let's talk about the type of people we'll be using. I'll be talking about non-degreed people.

The operators of the systems I've talked about today will typically come with a drafting background. Why drafting? We tend to find that the people who have a drafting background have the best skills in geometry and analytical geometry, etc. They are able to envision things in their head.

The second type person that we'll see a lot of is the service people. These systems break. They are not magic. They really do break down. We need people to do hardware and software service.

Another type of person that we'll be using is the person that will assist in the development of these new machines. Remember, I said we are growing at the rate of 40 percent per year. We are pretty voracious in sucking up electronic technicians and the programmers in building systems like this. We need people who can conceptually think them out.

In closing, give us the people with good analytical skills, programming skills, physics skills, geometry skills, etc. We can use them. We can use them well. Thank you.

ROBOTICS
BY RICK BUTTON*
TEXAS INSTRUMENTS

We are here to talk about increasing productivity in this country. Let's begin by grasping the realization that repetitiveness, any sort of repetitiveness, is not a good thing for a human to be doing.

We have found very often, on any kind of a repetitive job, that a person can stand up and do something a couple of times very well. However, starting at about the third or the fourth time, a person begins to have problems because the mind starts to wander and begins to think of other things. Repetitiveness by a human is on its way out.

Now that we've grasped that understanding, I want to explain what a robot is, why we should have robots, what technologies are involved, what the major applications are, and what skills are required.

Robotic Parts

Robots are nothing more than automation. It is true that they are displacing workers. However, robots will actually end up creating more jobs. The key feature is that these will be creative jobs.

A robot has basically five parts:

1. Manipulator (i.e., electrical arm);
2. Computer Controller (i.e., intelligence);
3. Sensors (i.e., vision, tackle, and switches to tell the robot what to do and help it make a decision);
4. Human Interfaces (i.e., allowing you to teach and tell it what to do);
5. Tooling (i.e., to structure the environment correctly for the robot).

I might add, in regard to manipulators, that to place an object in space in any random orientation requires six degrees of freedom. The human body, for example, has more than six degrees of freedom. Examples of six degrees of freedom with the human body involve the movement of the: (1) trunk; (2) shoulder; (3) elbow; (4) forearm; (5) wrist; and (6) hand. A robot must have that kind of movement to locate and orient an object in space.

We are starting to see a trend toward electric arms. We are also seeing small assembly arms arriving on the scene. Westinghouse, Olivetti, and General Electric are very much into manipulators (arms).

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Computer controllers are actually the real reason that robots are catching on. Basic robotic technology probably dates back to the 1930s and 1940s. Manipulator mechanisms are nothing new. The driving force behind the increasing use of robots is the intelligence capability of a computer, and its being able to communicate with the human effectively. That is what is driving the robotics area.

I might add that each company has a little different idea of how robots and people should communicate.

Interfacing With Robots

Let's talk about how we interface with the robot, and what the different human interfaces are. There is a real challenge in this area, to be able to communicate effectively with a robot.

We are starting to actually use CAD/CAM systems to drive the robots so that you can see what the robot is going to do with respect to environment (i.e., moving an object from one spot to another, welding, etc.).

Some of the little boxes that have been designed have specific functions to tell a robot to move Joint 1, move Joint 2, or move in a linear coordinate system, etc. One has been developed that actually lights up a light on a two dimensional display to show you what the robots look like so that you know which one you are moving.

There is a real need for people who understand how to communicate with other people, who understand the human interfacing capabilities when it comes to working with robots.

Sensors

Let's talk a little about sensors. This is a very exciting field. We are heavily involved with vision. That is actually one of our fortes.

The robot is fairly dumb. It will only do what you tell it to do. However, if you provide it with some external sensory capability, it can make some decisions on a limited basis and react to different situations differently. What we are trying to do is give vision to the robot so that it will be able to do the same thing that a human would do.

For example, I place an object on a table. I close my eyes, turn around several times, and then try to find the object with my eyes closed. I have problems. If I open my eyes, my vision helps me find the object without any problem. The robot, like the human, needs extrasensory capabilities. Thus some of the solutions here are vision and tackle.

By way of illustration, picture a wrench moving down a conveyor belt. Watching the movement of the wrench is a small assembly type robot which is actually a TV camera. A little box (computer controller) signals the camera (sensor) which locks-in on the wrench, develops coordinates on the wrench, and tells another robot (arm) where to go and pick it up. The robot which actually handles the wrench might well work on infrared signals.

Sometimes it is very beneficial, depending upon what the application for a robot is, to be able to see in different wavelengths from what the eye can see. It's not uncommon for a system to work in the infrared area. In fact, GM and Ford are working with infrared, gamma rays, X-rays, and with every ray that was ever talked about. Different applications have different meanings.

One of the things that I am trying to get across here today is in this field, we don't need specialists. We need generalists. We need people who can work with all kinds of technology. We don't need people who are going to set the world on fire in any one area, but we need people that are familiar with mechanics, software and computers, and electronics.

Getting back momentarily to vision, we are actually starting to make some of our robots mobile by giving them some vision or some sort of sensory device enabling them to avoid obstacles and find their way around the room as well.

Several years down the road, robots will start replacing people in a variety of environments, such as working in a nuclear reactor, where there are obvious environmental problems such as radiation.

Another thing that is being done with robots is to give them a sense of touch, especially in doing insertion or assembly type work. Have you ever tried to insert a screw into a hole? We are not always adept enough to get that screw straight into a hole every time. A robot is adept.

Let's look briefly at the historical development of robotics. A man by the name of Joe Engleberger is the George Washington of robots. He started in the early 1960s.

We started with some crude computers, some crude mechanics and did manipulation of robots.

As the computer technology has increased, we have been able to do more and more. The sensors are giving us the capability of being able to turn things around quickly so that we don't have to do a lot of hard tooling to structure the environment for the robot.

Let's take an example. If General Motors is building big cars and wants to switch to building smaller and more efficient cars, it will take several years to redesign an assembly line unless robots are involved, and the switchover can be minimized by reprogramming the robots to do different tasks. It won't take as long to turn things around.

Keep in mind that people are very flexible, but their attention span really is not very long. What we are trying to do is convert from manual labor to a creative or knowledge based labor force.

Implementing Robots

Let's talk a little about the kinds of decisions that are involved in implementing a robot.

If you have an operation, whether it be an assembly or machine type operation, it's better to have people do the job if you are just going to make or assemble 10 or 20 items.

If you are going for a high yield and consistent quality, then you need some sort of mechanization or automation, such as a stamping press or something that would do a specific item and that is all it would do.

If you want to go for a medium yield and consistent quality, you want to go with flexible automation, using robotics. You don't want to buy $100,000 worth of equipment just to do one item and then two years later that business goes away and you're stuck with a lot of capital equipment that cannot be used.

However, if you are using robots, such as a generic robot, you can reprogram them to do something else.

The question becomes one of how do you use your capital effectively? Sometimes you have special requirements; thus, you build your own robot to do that, which is what a generic robot would be. Generic robots cannot do a lot of things that some of the bigger robots can do, but they are very accurate.

I won't go into detail, but I just want to mention we also have the general purpose robots. You have been seeing a lot of these.

Industry Structure

Let's talk about how the industry is structured. We have basically three types of robot products: (1) low technology; (2) medium technology; and (3) high technology.

Low technology has been around for quite awhile. It is less than 9 percent of the market. They are usually a pneumatic or hydraulic cylinder. They have fixed stops and are programmed mechanically.

Seiko makes a pneumatic type arm. There are a lot of applications for these, but it takes a little more fixturing or a little more tooling to be able to use these kinds of robots.

A medium technology robot is circle controlled. It is programmable via PC, which used to be a Programmable Controller, but is now a Personal Computer. You can still do it with both.

These robots usually have cylindrical, spherical, or cartesian coordinates. For example, the actual mechanism might use a spherical coordinate system where it would have an arm that would go in and out and rotate around in different directions.

The high technology robots are circle controlled, but the key thing here is that they have a coordinated axis motion. To give an illustration, when you pick up an object and move it from one place to another, your wrist changes as you move in conjunction with your body movements. It all is a flowing type motion. This [illegible] happens with high technology robots.

With the medium technology, movement is more awkward. We are now getting to the point with the computer technology where we can control the robots whereby their movement is just as smooth as a person's would be. This is a huge emerging market in this country.

I am involved with a professional society in the Dallas/Fort Worth area, called Robotics International of the Society of Manufacturing Engineers. The issue of how much growth is really a question that we have been trying to address. In a year's time, we gained 120 members.

There was a robot conference in Detroit last fall. There were so many people in the building that the fire marshall had to close it down because it became dangerous.

There are over 40 companies in the U.S. market and several imported products. Many of the industry leaders are building new plants.

The driving factors behind a lot of this are the need to improve productivity to remain competitive, industry moving toward flexible automation, better utilization of capital, better return on investments, and lowering the total costs of robot solutions. The computer is the driving factor behind lowering costs.

The robot market leaders are Unimation, with 40 percent of the market, and Cincinnati Milacron, with 30 percent of the market. Unimation was first into the market. Others in the market include: ASEA (which is a Swedish arm), PRAB, Devilbiss and Coppelwell.

What is a PRAB robot? It runs back and forth on a track. It is a cylindrical robot. This is what we term a medium technology robot. It rotates about a base, moving in and out. It has a spherical coordinate system.

Devilbiss started off in the spray painting industry, which is really where their strength lies. The spray painting industry is turning more and more to robots. It is not a real nice environment for humans, in terms of the actual spray painting.

Power Devices

What are some of the technologies that are involved in robots? Let's talk about some of the power devices.

Right now, a lot of the large robots, such as those you see on TV, are hydraulic. The nice thing about hydraulic mechanisms is that you can get a good power to weight ratio, much better than electric or pneumatic.

Both hydraulic and pneumatic, however, have problems. They are non-linear. Therefore, it is harder for us to control them with a computer.

Pneumatic robots are relatively cheap. There's air everywhere. However, air is compressible and therefore it becomes very difficult to achieve stability.

Electric motors seem to be the wave of the future in terms of driving robots. They are very controllable. They are predictable. You don't have the conversion (energy) loss. The electric motors have a much smaller loss than the air.

Computers And Controls

Let's talk about computers and controls. One of the things that is really working out very well for us in the robot industry is the many new storage media coming onto the market. You have probably seen what is termed a floppy disk on personal computers. Those are working very well.

Among the storage media that are coming down the road are laser disks. Phillips is about to announce a new laser disk that you can write once on it, and be able to read it, and it will hold a giga bit (one billion bits) of memory.

There are a lot of new things that are coming out in the storage market that will give us some flexibility to do more sophisticated programming, which will make it easier for human interfacing and that sort of thing.

Innovations in the area of communications are enabling us to link Computer Aided Design systems with the robot, and to also network all of the robots to one common storage facility.

There are lots of different computers and displays on the market. We haven't quite gotten this technology to a point where everybody agrees that a certain way is the best way to do it. The reason for that is you may not want to do it the same way I do. We need to provide flexibility.

There is a lot of different electrical interfacing technology on the market. It may be visual, analog, or relay logic.

The programmable controllers that have been out for a few years are actually addressing relay logic. We think that for simple robot applications, they will probably be sufficient for programmable controllers.

Let's not throw relay logic away just yet. Computers are coming, but programmable controllers, which emulate the relay logic, seem to have a good human interface for low skilled type persons, such as you might turn out of the high school.

One of the things that most people pass up when they talk about robots is that a robot, in itself, is pretty easy to use. The hard thing about making a robot actually work on the manufacturing floor and be productive are the system aspects.

The basic robot, without any senses, is very dumb. It can only do, over and over, what you tell it to do. It is also usually not extremely accurate.

If you develop hard tooling, you can develop things that are very accurate and very repetitive, but the basic robot, being a general solution, usually is not as accurate.

Tooling

Just as you can have trouble finding something without vision, the robot would have the same problem unless you structure the environment so it knows where to pick something up. There are all kinds of fancy tooling to help guide the robot, and to present parts to robots.

Tooling is really a crucial issue that can be solved right at the high school and community college levels. You need to teach concepts that are involved in tooling.

A lot of it is guiding a robot. It is just chamfering (beveled edge) your part. If you have ever looked at the TI calculators, they are not rounded and/or beveled edges for just any old reason. It is the same with a robot.

The robot has a chamfered pick-up which allows you to be a little off in picking up a part and still be able to pick it up.

Those concepts could be taught very well in a shop and drafting environment in the high school.

Applications

Let's talk about the customer base and the kind of applications that are really being seen and used in industry right now.

The biggest customer base is the automotive industry, which accounts for about 50-60 percent of the robots used and 30 percent yearly in robot sales. GM and Ford are obviously the base purchasers. They intend to purchase about 18,000 robots by 1990.

Now remember, a robot isn't necessarily like a piece of higher automation where three or four years down the road it may cease to be used when a product has exceeded its life cycle. Robots are going to be around for a long time because they are reprogrammable. When you compare these numbers with higher automation purchases, they are a little bit staggering.

Robot users have been big companies, with inhouse application staffs, like at Texas Instruments, to do the systems integration. The hardest part about any robot is doing the actual systems integration, which is figuring out the tooling and getting the systems to work. Programming the robot is about 30 percent; the systems work is another 40 percent; and the electronics involved are pretty standard now and involve the other 30 percent.

Some of the different application areas for robots are: spot welding (48 percent of what robots are used for); die cast load and unload (20 percent); arc welding (8 percent); and spray painting (6 percent).

Examples of applications include: a General Electric robot doing spot welding on an automobile assembly line; a PRAB robot doing machine loading and unloading in a furnace in the casting industry; a Unimate robot picking up very large cumbersome heavy parts; a Cincinnati Milacron robot doing arc welding.

Using robots in arc welding is really starting to take-off right now because sensor technology is getting us to a point where robots can do some of the things that a human automatically would do with arc welding. Spray painting is another area, as I mentioned earlier, where you can make good use of robots. If you have ever been around just your household aerosol sprays, it is not a good environment.

Let's talk about the different classes of robots that have been developed. Right now most robotic applications are in the hazardous environments and super-human environments.

The hazardous environments include toxic fumes, high temperatures, flying metal chips, hot sparks, radiation, and danger of injury from machines.

The super-human environments involve heavy payloads to be moved, long reach, high speed, and high accuracy that you just can't actually do yourself.

Some of the things that are coming down the road in the future include super-human complex tasks which are highly repetitive, and like we mentioned earlier, humans aren't very good at that. The complex motions involve time, position, and sensory input. There, of course, will be human tasks involved.

Spot welding is the main application for robots right now, as well as some simple material handling type things. Looking down the road, robots will be able to do complex assembly and stacking types of operations. Robots are going to be very good at doing those things.

Skills Needed

Let me address quickly what skills are needed. We've talked about the electrical areas involved with robots. There is also a lot of electronics, pneumatic plumbing, and that sort of thing.

In the area of computers, we really could use some people who can program in Basic and Fortran, which are really the older technology languages, and Pascal and C, which are the new languages that are coming down the road. The software, of course, programs the robot to actually go through its movements.

You should work with industry in securing equipment to give your students a feel for what robots are like and what they do.

Personal computers will become more prominent in robotics. We will need entry level workers who know computer techniques with regard to manufacturing processes. Some of the people that are implementing the robots right now and doing the actual applications, get involved in a heavy amount of justifying the economics of the robot.

Human factors and safety techniques are important skills. You probably heard about the man killed in Japan. He jumped a barrier that was to prevent him from getting into the working area with the robot while it was operating.

We need workers with backgrounds in optics and sound. Optics is with the vision and sound for sensors. We are actually using some of the polaroid type sensors that you see on the cameras now to measure distance. Basic skills in optics and sound could be taught as an application to the mathematics that you're teaching in school.

The idea that I've tried to convey is that we want to increase productivity. We need to do that to be able to compete with Japan, to be able to keep our products growing and also to provide a better environment. We want and must invest in our human resources in order to be able to do that.

Thank-you.

Editor's Note: Following Mr. Button's presentation, two videotapes were shown, providing the audience a graphic overview of the various points noted in his speech.

PRIVATE SECTOR INITIATIVES
BY ROB MOSBACHER, JR.*
MOSBACHER PRODUCTION COMPANY

My presentation is on Private Sector Initiatives, which is something near and dear to my heart. I'll speak to it with particular relevance to technical-vocational education programs.

Let me begin [illegible] giving you just a little bit of background about how [illegible] came to be involved in private sector initiatives. I spent eight years in Washington, D.C. working for Senator Howard Baker. During my years in Washington, I had a chance to observe first-hand how our government had grown far beyond its means in capacity to deal with the ever increasing list of problems that were brought to its doorstep.

In fact, I think it's fair to say that up until maybe November of 1980, government had come to be viewed by many as the first, last and only resort for the treatment of virtually every social and economic ill afflicting this country.

National Mandate

In November 1980, I think the American people said fairly clearly that they had had enough and that the time had come to cut drastically the size and cost of government.

It's not enough simply to eliminate programs and hope the problems are going to go away because they will not. I think rather that it's incumbent upon us as a nation to find new creative alternative means of dealing with these old social and economic problems.

As a nation, I think we have come too far in the evolution of our social conscience to put up with suffering among our neighbors for long.

Even though public support for the president's effort to reduce the size and cost of government remains high, patience among many is wearing thin. I'm sure you see as I do, night after night, the suffering on television. The pressure is building to ease that suffering and with good reason.

I personally don't believe we could survive another trip down that road. That's not to say that government has no role to play in helping those who can't help themselves, but rather that role must be reduced and augmented.

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*Rob Mosbacher, Jr., is Vice President, Mosbacher Production Company, Houston, which is involved in the production of oil. He is a lawyer. He is a member of the President's Task Force on Private Sector Initiatives.

That's where private sector initiatives come in. I believe private sector initiatives offer us an opportunity to deal with a broad range of problems at a fraction of the cost and with far greater precision that you will ever get out of Washington, D.C. But in order to realize these savings, we have to get organized and we have to increase the breadth of participation in the process.

Defining the Private Sector

Before going into exactly how that might happen, let me try to provide a couple of quick definitions. Let me define the private sector for you first.

Contrary to common belief, the private sector consists of more than just the business community. It consists of religious establishments, academic institutions, non-profit groups, civic organizations, as well as service providers and recipients. It's a broad list of people. When I speak of the private sector, I'm really speaking about all those different groups.

Examples of Private Sector Initiatives

Now what are private sector initiatives? In their simplist form, private sector initiatives are efforts by individuals or institutions in the private sector to deal with the social or economic problem either directly or in concert with government.

I'll give you a few examples. In response to a cut in government funding for summer jobs for disadvantaged kids, a coalition of businesses in Houston went out and solicited summer jobs from their colleagues. Even in a bad economic climate we came up with 3,000 jobs in which kids were able to get that very, very important early work experience and exposure to the work market.

In Dayton, Ohio, a Rotary Club decided to adopt a day care center that was being used by people working in a factory nearby. The Rotary Club realized that if the day care center closed, many of the people employed by that factory would have to stay home with their children. They would probably lose their jobs and then become welfare recipients, costing us much more than we were spending on day care.

As another example, back here in Texas, a group of volunteers in Midland worked together to repair the homes of the elderly and the handicapped. They used materials donated by individuals, churches, clubs, and businesses.

More recently, the Frito Lay Company in Dallas undertook on their own a project to help former employees of Braniff Airlines find new employment when Braniff went out of business.

These are private sector initiatives. This is what we are talking about.

Despite the enormous opportunity that exists for the private sector to cushion the impact for many of the cuts in government funding, it cannot possibly nor should it try to fill the gap dollar for dollar or program for program. That is not what we are about.

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Goals of President's National Task Force

Having said that, the question is what can a national task force of private citizens, appointed by the President approximately a year ago, do to encourage this sort of thing? What can we do to make a difference?

We thought about it for quite awhile. We decided the first thing we would do is just forget the idea of writing a report. Most blue ribbon panels write reports that are never read by anyone and amount to no consequence.

Instead, what we decided to do was to settle on a couple of goals. First and foremost is to encourage the creation or continuation of private sector initiative committees in communities across the country.

This is in recognition of the fact that the action, in terms of people solving their own problems, does not happen in Washington, D.C. It happens at the community level.

Now what we wanted to do as a task force was to serve as a catalyst for the creation of these things if they didn't already exist.

How would they work? Well, their job would be to identify their local problems, place them in some sort of priority, eliminate from consideration those on which the private sector can have minimal impact or in which the private sector is already working effectively, and then try to match or marshall the human and financial resources available to the problem.

What we hope to establish is a process at the local level that will involve private sector leaders on a continuing basis in community problem solving. Often that involvement will entail working in partnership with local government or governmental entities.

We're not trying to duplicate what other people are already doing. All we really want to do is try to build upon those efforts, hopefully coordinate them, and if possible, determine in light of budget cutbacks, what's being covered and what's falling between the cracks.

The second major goal of prime importance to our task force is to catalog models or examples of proven private sector initiatives from around the country. Examples such as I mentioned earlier.

What we want to do is find private sector initiative models that deserve to be recognized and replicated elsewhere in the country. What we do is take these examples, such as the one from Midland about repairing homes, and develop brief summaries on each.

The summaries are then put into a computer in Washington, D.C. When Seattle wants to know what you can do to deal with the housing problems of the elderly or the handicapped, the Midland example will come out of the computer. We'll send it to Seattle and encourage them to contact the person in Midland.

What we are trying to do is provide something of a cross pollenization service by taking the best ideas from one community and planting them in another. This helps to avoid reinventing the wheel. There's an enormous amount of creative genius in this country that deserves to be tapped and recognized.

Having listed our two primary goals as encouraging the creation of local private initiative committees, and identifying examples, the question becomes is our task force making progress?

The President formed the task force in December 1981. It goes out of business at the end of this year. Time is running out. Are we making progress? What relevance does this have to technical-vocational education?

On the question of progress, I think the answer is an unqualified yes. Let me give you a specific example.

The Houston Story

Houston has a very vital private sector, but until recently we had no private sector group that looked at social and economic problems on a continuing basis and then tried to deal with them.

We have a very vital and active Chamber of Commerce in Houston. We have proven ourselves very capable of mobilizing to deal with problems on an ad hoc basis. However, there was no continuing involvement of private sector leaders to deal with social and economic problems.

We felt there was a need for one of these private sector initiative committees. We asked the chairman and chief executive officer of Tenneco and the head of our Chamber of Commerce to serve as co-chairmen of such a committee. They both agreed.

We put together a committee in Houston of some 20 men and women. We're terribly excited about the group and the capabilities they bring to bear. There is a very strong representation on that committee of people from academic institutions.

We spent the first few months of our existence trying to look at the long list of problems in Houston, deciding on what we could really have an impact. We looked at where the federal budget cuts would be most severely felt, and at where we could contribute and where we couldn't contribute much.

The three are: (1) day care services for children; (2) housing and neighborhood revitalization; and (3) employment training.

It's the third area that is of particular relevance to our discussion tonight. In the area of employment training, it became apparent that one of the most underutilized resources, at least in Houston, was the community colleges.

Consequently, several months ago, I met with a group of presidents and board members from community colleges throughout the Houston area. At that meeting, it was agreed that while a broad range of technical-vocational education programs exist in Houston, there is little awareness on the part of the corporate community, much less our Chamber of Commerce, as to the role these institutions can play in training employees. We're talking about training for not only businesses that are already in Houston, but also for the businesses that we're trying to attract to Houston who need new employees.

The meeting resulted in the Houston Committee on Private Sector Initiatives agreeing to help establish effective communications with the Chamber of Commerce and to help overcome the lack of awareness in the corporate community.

The community college group was asked to do an inventory of all the programs they offer, listing them by career area, so that we can take that compilation and circulate it, or market it throughout the city.

I met again this morning with the community college group. The city-wide inventory has been completed. We are now working on a marketing program to rectify the problem of awareness with respect to the availability of these very important job training programs.

Computer operations is among the many high technology career areas in which training is needed and for which there is a growing demand.

Through this partnership between the business community and technical-vocational education institutions, we will be able to significantly increase and improve the availability and use of this very cost effective method of providing job training.

My reason for telling you this is not only to give you an idea of the concrete progress that we have been making in the area of private sector initiatives, but also to encourage you to participate in the partnerships being formed throughout Texas.

Statewide Task Force

Governor Clements believes firmly in the importance of greater private sector participation and local problem solving. He has appointed a Statewide Task Force on Private Sector Initiatives to assist in the creation of these local private sector initiatives committees. His task force consists of individuals who are presently chairing committees in their communities or will soon be establishing those committees.

Coupled with his strong and unequivocal support for technical-vocational education in Texas, Governor Clements is taking the necessary steps to consummate a very good marriage of the business community with those in a position most capable of providing trained employees to meet our growing labor demands.

Local Initiatives Must Continue

Although the President's Task Force will go out of business at the end of this year, local private sector initiatives committees should continue indefinitely. What we have done, hopefully, is laid a solid organizational base. What we're asking for from individual citizens is a commitment of your time and your expertise to the treatment of your local problems.

We'll raise some money, but that's really the job of others, such as the United Way, who are in business to do that right now.

I'm reminded of a story the President likes to tell about a young and eager United Way fundraiser who had made a list of people in his town who were making over $300,000 a year and were not contributing any of it to philanthropic causes.

This young fundraiser said we can't let them off the hook like that. He made an appointment and went to see one gentleman. He said, "Sir, our records show you're making in excess of $300,000 a year and you're not contributing one cent of it to charitable causes." "That's right," said the older man. "But did you realize that I have a brother who's been disabled since World War II, and I have a widowed sister who has four children to support."

"I did not realize that," said the young fundraiser. "That's right," said the older fellow. "And if I haven't helped them what makes you think I'm going to help you!"

Those of you who are in the business of trying to raise money may have encountered someone like that. I sure have. Fortunately, it's more the exception than the case.

In any event, the beauty of private sector initiatives is in making a minimal amount of money go a long way by leveraging it with a commitment of time and expertise from individual citizens. Whether you participate through your business, your church, or your work establishment, we need for you to get involved.

I hope you will look at this not as a philanthropic endeavor, but rather as an investment in your community and in your country.

Profit is the most important incentive in the business world but profit can extend far beyond the bottom line of a balance sheet. It can benefit a whole community.

Tradition of Voluntary Service

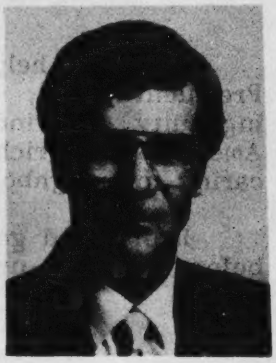
Although we have our work cut out for us, we have a tradition in this country of voluntary private service that simply doesn't exist to the same extent elsewhere in the world.

Indeed private service today is a $150 billion annual enterprise, out-stripping the combined 1982 budgets of eight cabinet departments of the U.S. government. More than 84 million Americans volunteered for such work in 1980, with half of those volunteering five hours each per week.

It's on this remarkable heritage of private service that the President and the task force wish to build. We want to encourage still greater private contributions of time and talent as well as money. We want to try to form a creative and strong partnership between America's private citizens and their public servants.

You can help us build upon that foundation so that we can, as the President says, "Rediscover America." The America whose initiative, ingenuity, and industry have made our country the envy of the world. The America who's rich tradition of generosity began with simple acts of neighbor caring for neighbor.

Ladies and gentlemen, I believe we have a unique and historic opportunity before us and I urge you not to let it pass. Thank-you.



ENERGY

BY MIKE PAPADOPOULOS*

SHELL DEVELOPMENT COMPANY

It's a pleasure to be with you today, to discuss your role in helping meet the technical manpower needs of the energy industry.

This conference reminds me of the story about the child that had not uttered a word in its first five years of life.

One morning at breakfast, the child looked up at his mother, and said, "Mom, the breakfast is fine, the eggs are great, but you burned the toast a little bit this morning."

She, of course, almost fell over in shock at hearing the first words ever spoken by her son. She said, "How come all of these years you haven't said a word?" The child responded, "Well, so far everything has been okay."

Personally, I think the education system in Texas has been quite okay. I am very proud of the job that you have been doing in Texas.

My job this morning is a very humble one, to give you a little perspective as to how we see the impact of high technology on the energy part of the world.

Let me give you a preview of what I'll be talking about. It's going to be a two-way street, with your students directing the traffic.

First, let's have a little historical perspective. The former backbone of the U.S. economy -- old line manufacturing industries like steel, autos, rubber, textiles -- will constitute a smaller share of the nation's employment.

Instead, employment will grow in the high technology, service and information sectors, as our nation enters the so-called "postindustrial age."

Transition Will Affect Everyone

Who will be affected by this transition? It will be workers, unions, corporations, taxpayers, and perhaps most importantly, it will be our schools and their students who have yet to choose vocations. A recent government study shows that the jobs of the future will be in such fields as computers, engineering, accounting, banking, physics, economics, law and health care.

But basically, because of its pre-eminence in high technology development, the power of the computer is what it all boils down to. As Ben Fischer, a labor expert at Carnegie-Mellon University in Pittsburgh says, "Increasingly, the kinds of things that require no skill are going to be done

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*Dr. Mike Papadopoulos is Vice-President, Shell Development Company, Houston, Texas The Shell Development Company is the research arm of the Shell Oil Company.

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mechanically and not by people."

To some degree, this is already happening in the energy industry -- at oil refineries, chemical plants, research and development complexes, and product distribution centers.

Where Energy Field Is Headed

Where is the energy field headed, in terms of this high technology? First, let's consider the impact of the energy industry on the U.S. in terms of contribution to the GNP and employment.

Although the energy industry at the production and refinery level represents only about 5 to 10 percent of the GNP, it is integrally related to many downstream activities, such as petrochemicals, transportation, oilfield design and service, engineering and services, wholesale and retail sales. All of these fields use similar instrumentation and require the support of similar control-oriented equipment, like computers.

So the aggregate activity in the energy industry makes up a significantly greater piece of the GNP pie, and also provides important employment opportunities.

In the energy industry, we're already spending 10 percent of our resources on computers. In research, we're spending even more. In terms of people who are required to have some computer training, the relative cost is at least as much.

As you have already heard at this conference, in the late 1980s, whether in the office, in the lab or in the field, we see an increasing need for people who are familiar with operation computer control systems, data processing systems, word processing, electronic mail, manipulating data in automated experiments and so on. This need will grow geometrically.

We suspect that 50 percent or more of people who will be employed in our business by the end of this decade with technical-vocational training will have to be very conversant with computers. Already, better than half of the university graduates we employ are proficient with computers.

And that's where we get back to that two-way street I mentioned earlier, where your students will be directing traffic. That's where I see the very tangible contribution of your students: as the interface between those who have absolutely no familiarity with this high technology, and those at the other end of the spectrum who basically shape that technology.

At The Heart Of High Technology

Advances in this high technology in the energy field center on, basically, computers and instrumentation. Continuing progress in this area allows us to both manage and control our business much more effectively than in the past.

Let me give you some examples of uses of this equipment, and some of the various environments where it is applied.

First, let us consider our new computer building at our Westhollow Research Center in Houston. People working in this facility are developing computer process control hardware and software that will wind up at one of our manufacturing plants, to control the units that make gasoline and lube oils and chemicals.

The hardware is contained in the boxes that we've all seen before. The software -- that piece of the "package" that gives us control of a function or functions -- is accessed through the operator's terminal, where actual components of the plant are depicted.

Zooming in on that "TV screen" we see a reactor, a distillation column, and flow paths of crude oil, heat, electrical signals and various products from the process. Working with this software is not a passive job -- it's interactive -- using these computer systems you can manipulate various aspects of the process like pressure, temperature, the opening and closing of valves, etc. You can do these things at the console, totally remote from the plant, and you can see the effects of your manipulations.

As a second example, let us consider our secretaries at Shell. Our secretaries are already becoming familiar with the use of computers. I think I can safely say that by the end of this decade, there will essentially be no secretary who could do the job effectively without intimate knowledge of computer language and computer operations.

I'm not saying that our secretaries have to be a systems programmer, nor do they have to know how to maintain programs. But they will have to be conversant with the concept, the way in which things have been put together, displayed, filed and retrieved.

As a third example, let's take a look at the operator/maintenance technician at a refinery. Whether they work at the actual production unit or in the office, they will still have to call on a computer before going out to service a pump or valve.

They'll ask the computer to show them the maintenance file of, say, a valve, rather than hopping in a pick-up with a set of wrenches, hoping to find a particular seal that's leaking. Instead, they'll go back into the computer file and examine the maintenance history of the valve. They'll check the computer file to see what parts are on inventory for this particular valve.

Then, with the information they've gathered, and the required part, they can hop into a pick-up with a set of wrenches and go fix the leaking seal.

As a fourth example, let's get back to Ben Fischer's statement that work requiring no skill will be done mechanically. There are some operations in the energy industry that would be amenable to robotics.

We have a high-rise, fully automated warehouse in Wilmington, California. Picture in your mind a honeycomb rise, with the inventory located in individual cells.

A variety of products -- cartons of quarts of motor oils, greases, etc., are brought into the honeycomb on a conveyor belt, which is computer controlled.

As the inventory passes through a control station, it "tells" the computer what it is, pretty much like the laser checkouts at your supermarket these days. And the computer automatically assigns a location in the honeycomb for each box. Then when a truck pulls up at the loading dock with a bill of lading the computer can read, the computer will signal a robot that will go through the highrise on tracks, to say, apartment 10B, pick up the order and put it on a conveyor to the loading dock.

As a fifth example, we have just installed another kind of robot at our Information and Computer Services Center in Houston. This one picks out seismic tapes from a library of hundreds of thousands of such tapes.

The robot runs on a monorail at relatively high speeds -- 20 to 30 miles per hour -- over about a 75-foot run. This robot, besides being fast, has hot lips! It kisses the seismic tape it's looking for, abstracting it from the library and taking it to the computer. That's the repetitive, dreary type of thing that really turns on a computer, but would bore to death a file clerk, who may grab the wrong tape anyway.

As a sixth example, let's take a look at one of our labs. In order to make detergents, we have to test a variety of catalysts.

This is a very complicated process, and is very exacting in the types of measurements that must be made, requiring a lot of technician time. By technician, I mean a person who is vocationally trained: typically with a couple of years of college or other comparable training or education.

This person now, rather than running these tests manually, will oversee banks of totally automated experiments. For example, consider a bank of 16 catalyst reactors in a row. One "super" technician can come in, look at the CRT, make a few adjustments and go on to something else.

As a seventh example, and again, in our research labs, highly advanced instruments, used to characterize surface data, are operated by technicians. The data generated by these instruments is then relayed by a communications network to those researchers who need it.

Just in our research effort, we're finding that we are spending at least 10 percent of our technology dollar on analytical instrumentation. That's on top of the 10 percent of our technology dollar that is spent exclusively for computers. The whole analytical area is extremely highly automated. It is becoming increasingly common for a piece of equipment costing several million dollars to be run by a technician. The technician is doing the things that a professional used to do, enriching the quality level of skills for the technician.

At the same time, relieved of this type of work, the professionals have more time for their specialty: productive invention and innovation.

As an eighth example, let's look at toxicology. Toxicology, the way we practice it at Shell, is a defensive way of finding out what the effects of our chemicals are, in a toxic sense, before they are sent out into the marketplace.

High technology at our toxicology lab controls the experiment and processes the data. And that's not all. It also allows the pathologist to speak

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slowly, and in simple words, what his microscopic observations are as he's making them, not into a tape recorder, but into a computer.

I don't want to imply that you can talk fluent English or Greek into the computer. You cannot. Presently, we have the capability of programming in a few hundred words that are directly recognizable by the computer. The net result is automated toxicology.

These are just a few examples of elements of high technology that are increasingly coming into play in the energy business, requiring skills specifically related to an understanding of computer language, software and instrumentation.

There is definitely almost an explosion in the types of skills that are software-knowledge related. Especially as hardware costs fall, the key effort and activity and cost remain software oriented, meaning how you handle what you've got. It's been estimated that fully 85 percent of the total high technology activity and cost is going to be connected with software rather than hardware.

Impacting Demand, Types Of Jobs

This high technology we've been talking about will have a definite impact on the demand and the types of jobs that will be available in the energy industry.

As far as people are concerned, in the manufacturing side of the business where chemicals and oils, etc. are made, there are now lots of people that operate the various units.

But the skills of these operators are changing, from physically going out to the unit and observing or controlling things, to doing the same thing from a computer control and display room, where several hierarchies of computers that control an increasingly larger aggregation of that plant hardware are located. We are moving more and more to the point where the whole plant is computer controlled by these operators, and we do have a lot of operators.

The jobs of these operators are definitely being enriched because they are in a more powerful position to actually make decisions. It used to be that key decisions were only made by people way up the chain of command. We have arrived at the point where the decisions are being made where the knowledge base is, and that's the computer control room.

So there will have to be a shift in the training of the people we now employ in these plants. Whether there may be fewer people or not needed in these plants, I don't know. They may be somewhat fewer, but the number will be negligible.

Shift In Educational Focus

For your students to be able to fill their role as the interface -- the traffic director on that two-way street -- there will have to be a shift in your focus as educators. This is not to say that you haven't been doing a very commendable job.

The energy industry is not looking nor expecting the schools to turn out the "complete high technology specialist."

The people you've been training, for the most part, are well grounded in the basics: chemistry, physics, mathematics, and english.

It's still very desirable for your students to have a good understanding of math -- not necessarily higher math -- but a good ability to handle numbers and their relationships, to be comfortable with them. And they'll of course still need some basic science, some chemistry, some physics.

What has changed is the overlay of the language of high technology, and that of software, and being able to understand it.

We at Shell encourage you to keep up the good work in teaching your students the basics in math and in the sciences, and add to that the basics of the state-of-the-art in computer software.

Anyone who comes into our business who doesn't know "BASIC," or "Fortran," though Fortran has more commercial than industrial applications, will be at a disadvantage. The same holds true for university graduates in skill areas we can use -- chemistry, chemical engineering or whatever, who do not have that kind of training. You've got to have it.

From what I have seen, I think that you in the education field have already recognized and are moving in the direction of offering courses in computers and software.

We'll take the job applicants who have an understanding of how computers work and how they can be used, and we'll familiarize them and train them to understand the language of what making energy is all about. We will provide the "marriage," if you will, of the two types of language.

As I think others at this conference have told you or will tell you, this vital knowledge of computer software is not unique to the needs of the energy industry. But in intensity, I'd say the energy industry is up there, say in the upper quartile compared to all of industry.

Industry And Education Linkages

Let me reassure you that you are already doing a commendable job. And I'd like to emphasize that it is in the enlightened interest of the energy industry and other industries, who hire your students, to donate equipment. I know that Shell is participating in several computer education programs with the Houston Independent School District, including the donation of equipment to the schools.

In New Hampshire, 12 new vocational high schools have been opened over the past decade, with plans to open 7 more in the next 4 years. These schools are all geared to providing workers with the skills they will need to produce in the electronics and energy and other high technology growth industries of our "postindustrial age."

Public schools in many communities are reviewing course offerings along these lines, to prepare students for available jobs. You school administrators will have to keep up with these new areas, to show your students the best routes to take for their future.

As our banquet speaker, Rob Mosbacher, said last night, it takes a lot of dialogue between both the educators and the people in business at the local level to keep each other abreast of just where we are heading in terms of needs, programs, and services. This dialogue must be continuous.

Thank-you.

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BIOMEDICAL ENGINEERING

BY TOM KROUSKOP*

BAYLOR COLLEGE OF MEDICINE

Biomedical engineering is a little different than the other areas of technology utilization that have been talked about at this conference.

In some of the other areas, you don't have the direct interaction with the people who benefit from your work. In biomedical engineering, you often do have the direct interaction.

When you do your job well, you see an individual that benefits from your expertise. When you don't do quite as well as you had hoped, you also see the affects of that.

Health care, especially biomedical engineering, is a growing area in our society. We have people living longer. Through the use of technology, we have people that are surviving accidents and diseases that would have been fatal even a decade ago.

There is a growing need for people that are familiar with electronic and mechanical technology as well as computer applications in the medical arena.

What is biomedical engineering? There are basically two areas that we will address: clinical engineering, which is centered around hospitals, particularly acute care hospitals; and bioengineering, which includes research and development as well as rehabilitation engineering.

Clinical Engineering

In the clinical engineering field, there is a growing need for graduates from vocational schools, community colleges, and other programs that have a very good understanding of both electrical and electronics technology.

We need people who can troubleshoot as well as perform routine preventive maintenance on the increasing array of equipment that is being used in the operating room, the ICU, the patient's room, and in the normal ward type operation.

There are also a number of computer applications that require people that understand integrated circuits.

Many operations today require a good bit of very intricate technology. Not only do you find the traditional surgeon, anesthesiologist, and nurses in the operating room, but you also find the electronic, biomedical engineering, and biomedical equipment technicians who are helping monitor equipment and who stand ready to replace equipment if there is a breakdown during an operation.

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Biomedical Advances

There have been a number of advances in the biomedical engineering area. Pacemakers and implant materials were among the first things that came out of biomedical engineering that really caught the public's imagination.

There is a growing market for graduates of technical programs that have an understanding of implant materials, who are good with their hands, and who can actually help shape these materials.

There are about 50,000 orthopedic implants a year, all of which require individual custom attention by a technician type person.

There are a number of heart valve replacements annually. These devices have to be put together by hand and then tested and evaluated. Technicians do much of that work.

The artificial heart program is alive and well in Houston. There are several varieties that are currently being used. For example, a left ventricular assist is used with persons that have a weak heart, perhaps a heart that did not respond well to by-pass surgery. There is a very great need for technicians to monitor, operate, and repair equipment such as the ventricular assist that are used in the heart program.

When a person is on a device such as the ventricular assist, there is a technician on call 24 hours a day at bedside watching the equipment. The technician makes sure the equipment doesn't malfunction, and stands ready to remedy mechanical and electronic malfunctions at the time they occur.

Other Biomedical Devices

There are numerous other devices that haven't made quite as many headlines as the heart program.

There are, for example, electronic devices that are used to control or reactivate muscles that have been paralyzed by a stroke, or to control spasticity in persons that have cerebral palsy or other disabling conditions.

There is also a lot of energy and effort going into the development of such new equipment as blood pressure meters that can be used to monitor blood pressure during exercise.

Monitoring blood pressure may sound like an easy task, but it is not. All traditional methods rely on sound being recorded or being sent and properly interpreted. When a person is moving around on an exercise bike or something like that, there are all sorts of sounds (i.e., straining) which create problems.

Whenever a person is in the cardiac rehabilitation program at the Medical Center here in Houston, there are clinical engineering technicians on call and present during the exercise episodes. It's their job to make sure the blood pressure monitoring equipment is interpreting information properly.

Another device that has been developed is the electronic nerve stimulator, which is a fancy way of getting around the old iron lung.

The implantation of the stimulator requires a sizeable number of doctors, nurses, and technicians to be in the operating room to assist the neurosurgeon. They make sure all the electronics are working properly.

An annual checkup is required for the person and nerve stimulating equipment. If a person doesn't use this type of a respirator, he or she is relatively confined to an iron lung.

An iron lung, of course, impairs the mobility of a patient. With the electronic nerve stimulator, the person doesn't have any noticeable gadgetry or equipment attached to them, other than being in a wheelchair.

The nerve stimulator allows people to exercise many more choices about what their lifestyle is going to be.

New Equipment In Rehabilitation

Biomedical engineering technicians and other technical people are required to develop a lot of new equipment. A device has been built by several technician level people, for example, that bends the arm or the leg for a person that has undergone knee or elbow surgery. It provides therapy as needed to get them out of the hospital quickly.

There has also been an electronic device developed that keeps track of how long people have been sitting or lying in bed. It is used with people confined to wheelchairs or to a bed, as a part of a program to keep them from getting bed sores. A physician will prescribe a time table by which disabled people will be moved about to keep them from sitting or lying in one position too long. The electronic device helps with that.

A device has also been developed to measure pressure under people when they are sitting.

Circuits And Computers

The world is working toward smaller and smaller electronic circuits. The biomedical engineering field makes use of printed circuits so microscopic in nature that it challenges the electronic industries that are putting them together.

There is a need for people who are familiar with microelectronics and printed circuits in terms of how they can be fabricated and put together.

Computers are also becoming very important and are widely used in the medical field. They are used, for example, to handle data processing in the hospital and for analysis in clinical laboratory tests.

Fabrication And Maintenance

As people get more experienced in the bioengineering field, they quite often move more toward the fabrication and maintenance of custom equipment.

There has been experimental work done on eye movement devices to provide a control interface for such things as wheelchairs.

NASA, for example, developed a device nearly a decade ago that allows a wheelchair to move in the direction in which the occupant is looking. The device has not been perfected. Considerable eye movement is a natural inclination of the human being, and with the NASA device being developed at the height of the mini-skirt era, the wheelchair was always veering off course.

Recreational And Vocational Aids

Many of the devices in bioengineering have a profound impact on the individual.

A device was developed for a guitarist who lost both arms in an accident. The device allows him to play the guitar. He doesn't play as well as before, but the device enables him to get pleasure out of activities that he enjoyed before the accident.

A polaroid sonar camera was developed to enhance the artistic skills of a quadraplegic who is a very accomplished mouthstick artist. The camera is mounted on a helmet and is used by the quadraplegic to photograph scenes and objects in nature. The photograph serves as the model for the artist. The camera allows the quadraplegic a little more freedom and independence.

An electromechanical system was developed to allow a bank employee to return to work after a stroke. The stroke had left the person with only the use of one hand and one foot. The device allows the use of the good foot and hand in running a check proofing machine. This electromechanical device, by the way, was developed by an electronic technician who was able to effectively use machine shop technology.

Environmental Aids And Modifications

As another example, a respirator device, different from the electronic nerve stimulator mentioned earlier, was developed to facilitate the breathing of a person confined to a wheelchair. The device sits on the bottom of a lap board on a wheelchair and pushes on the person's stomach causing the person to breathe.

This respirator device was put together several years ago by a senior technician at The Institute for Rehabilitation and Research. It has been copied and is now used by about 25 people across the country.

Technician level people often get involved in modifying people's homes, such as the elderly and disabled, so they can get around more effectively. A crane was developed, for example, that allows disabled persons to live in a home and take care of themselves. It is used to pick a person up out of a wheelchair and place them in a bath tub and on the toilet.

New Areas In Prostheses

An area in which biomedical engineering technicians are in great need is in the use of artificial limbs and braces (prosthetics). Technology has gone beyond cable controls for artificial limbs. Electrodes are now used to stimulate muscles which in turn move artificial limbs. Technicians are needed to operate the devices, evaluate the people using them, move electrodes around, and maximize the use of an arm or leg.

To my knowledge, there are no prosthetic or orthotic technician programs in Texas to provide people to the prosthetic industry, to build arms,to build arms to work with plastic, wood, leather and things like that. It's a very undermanned area.

Individual Needs

Instrumentation, which deals with the adjustment of devices or the custom fitting of devices to the individual's needs, is an area that requires considerable technician input and involvement. We get involved in a good bit of research, looking at instrumentation, understanding how it works, and how different aspects of technology are interfaced. Nurses, therapists, and the patient often don't care how a device works. All they want is for it to work everytime they want to use it.

Wheelchair repair is an area that a lot of people don't think about in terms of biomedical engineering. It is a very economically rewarding area for persons who have a good basic background in technology -- customizing chairs to individual needs and making sure they stay available and in working order.

In Summary

In summary, most of the needs in the biomedical engineering area right now are for persons that have good solid backgrounds in electronics technology, computer technology, and machine shop. There is a growing need for these people over the next two to three decades. It is envisioned by everyone that I have been able to contact, that this need will continue to increase as hospitals go more and more to automated procedures or diagnostic work, as more CAT scanners are put in place, and as ultrasonic technologies become available.

We need people coming out of programs that are well founded in the technologies. We need people that understand physiology, anatomy, hospital management, and how to make medical instruments and devices. Thank-you.

AEROSPACE

BY FRANK HURLEY*

GENERAL DYNAMICS CORPORATION

The General Dynamics Corporation is a very diverse company, manufacturing such weaponry as tanks, nuclear missile submarines, attack submarines, missiles, and aircraft. We also develop many of the sub-systems which go into these products.

Facilities are located in several states. We have plants, for example, in Michigan, Connecticut, California, and Texas. One of our facilities in California produces the Cruise Missile (Tomahawk) for the U.S. Navy. It and our Fort Worth Division are members of the aerospace group.

Military aircraft and ground electronics are the primary product lines of the Fort Worth Division.

The F-16

The airplane presently in quantity production is the F-16. Some 800 or so of this plane have been built and distributed worldwide. The F-16 is a small aircraft, originally designed for air-to-air missions to achieve air superiority. It is now multi-role, including use in air-to-ground missions.

The F-16 is a supersonic airplane. We are constantly producing modifications to this aircraft in its systems, equipment, and capabilities.

Originally, the F-16 was a design of the early 1970s. It was conceived, designed, and manufactured in a fairly traditional manner. Presently, however, this airplane and other military aircraft which we hope to produce are being approached somewhat differently.

CAD/CAM

Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) now play a very important part in the production of aircraft. Such functions, for example, as design, analysis (engineering), drafting, and documentation are done with the benefit of computers.

Ninety percent of the modifications which define the F-16XL version, including a brand new wing design, were done through computer aided methods. It was people interacting with TV monitors and computers rather than the traditional drawing board method.

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If you can track, data sort, and design complex aircraft hardware with computers, you can also do the same for the complex machinery that produces the airplane. This is indeed occurring at General Dynamics.

We have developed a robotic drilling apparatus, which has now been in operation for a couple of years. Certain parts of the aircraft are very amenable to the robotic drilling operation.

The tail skin of the F-16, for example, has something like 220 holes that need to be drilled. It is much more efficient if you do it robotically. It's a much better quality control situation to do it robotically than by operators with hand held drills.

You can, by the way, put different fittings on the end of the drilling apparatus, which allow you to rivet, countersink bolts, and also to inspect what's been done. These things are underway now.

Sub-Systems

Thus far, I have talked about the design and manufacturing of airplanes. We are also constantly engineering the sub-systems that go into them. (e.g., navigational system).

We integrate all the different sub-systems, engineering them into the airplane. Most of the systems communicate with each other and with the pilot over a computerized digital multiplex system.

We will see the day soon when jet fighters will by-and-large be flight controlled by digital electronics rather than through analog electronics, which came into being in the early 1970s, or through mechanical and hydraulic linkages which go back through this century.

Ground Electronics

Earlier, I noted that our Fort Worth Division is involved in not only aircraft, but also the ground electronics product line.

We have work going on right now on communications systems which revolutionize defense strategies. Most of you have seen the large transparent tracking board in a combat readiness or information room that is manned by several people working with grease pencils. Well, computerization is making the "grease pencil" a thing of the past.

A computerized tracking terminal allows you to very quickly keep track of and communicate battlefield situations and needs from one location to another. You can input to the computer the battlefield situation and it can respond with what your options are for meeting your needs. Uitimately, it can distribute the orders to commit your aircraft or army resources into battle.

Job Categories And Functions

Thus far, I have given you a picture of some of the things we do at General Dynamics. Let me now touch on some of the job categories of the people who presently perform these functions and will do so in the future.

On the factory side of our operation, you will find, more or less, traditional job descriptions. We're not hiring many people in the factory except those who have some fairly serious specialized training -- propulsion, airframe, assembler's license, etc. -- or equivalent work experience.

Over on the engineering side, you do find workers with two years training or education past high school and/or some particular background in their high school coursework, or some equivalent work experience. We're looking for draftsmen, laboratory assistants, clerical personnel, physical analysts (tech aides). We also have a need for people, such as editors and illustrators, who are involved with the paper that gets generated in any organization of this type, especially being a government contractor.

When you consider our Fort Worth and Abilene facilities here in Texas, we have abut 8,000 individuals working on the engineering, administrative, and professional side.

We have about the same number of people working on the factory side, most of whom have specialized vocational training.

Demands For Workers

The question you want answered is how are these numbers going to change as time goes by?

We say that over a span of several years, as the production trends that I described continue to evolve, we're going to do a couple times as much work as we are now but with the same number of people. This is true on the factory side as well as the engineering, research/development, administrative, and clerical side.

CAD/CAM systems and electronic mail, for example, are reasons why more work will be done without increasing the work force.

I was talking about paper a moment ago. We'll actually generate less paper as time goes by thanks to word processors and electronic mail.

Out in the factory, we'll see fewer people doing what we call "touch work" on the aircraft. We'll have fewer people running the machines. There will probably be an abandonment of the one man-one machine type of a situation that we've seen for a number of years.

We're going to need workers with specialized skills in the areas of computer software writing and computer systems operations.

We're going to need people who have both some background in assembling/machining operations and computer/software operations. It is not relevant to us whether they come to us with computer training and learn about manufacturing, or whether they come from the factory and take training courses in computers.

Having skills in both assembling/machining operations and computer/software operations is a very valuable combination as CAD/CAM and robotics come into play more and more.

By the way, we see an increasing need for "maintenance people." We're talking about two kinds of maintenance: (1) of the computer system and software; and (2) of the machines. These machines will become more versatile and more complex even though they tend to lose a human operator as an integral part of the operation.

What's it all about? What's the bottom line on everything I've been talking about? Here's a photo of one of our airplanes intercepting and escorting out of "harm's way" a long range Soviet bomber. Freedom. Defense. That's what it's all about.

Strong America

I would like to close my presentation with a 16mm film entitled a "Strong America." It will give you a good perspective of some of the automation that's being implemented in the factory. (Following is a transcription on the audio. Instructions for securing use of the film appear at the end of this presentation.)

"The strength of the land is in the people. The strength of the people is in their vision.

We dream of a better life. We work for it and we defend it. But we of all people know that peace is much more than the absence of war. It's a precious possession in need of renewal.

Peace is a strong America. When we are strong, we're at peace. When we're strong, we build a better world with ideas, with better ways of doing things. When we're strong, there is a spirit that gives vitality to every breath. Tomorrow will be better because we will make it better.

Productivity isn't just a word for big business. It's a challenge for every American. It's what built our country. It's adventure and accomplishment in the fullest sense. It's being a part of helping do something for our country. You know, some people don't look at it that way.

The United States Air Force and General Dynamics have responded to the challenge. In a mere three years, this aerospace factory has been transformed. What was once a relic of tired thinking in previous decades is now an innovative network of productivity improvements.

Integrated computer aided manufacturing is a system which provides quality, reliability, and performance, while saving money. Lots of money.

Some improvements are deceptively simple. Other improvements are simply remarkable.

Machines are used for what they do best. They extend the limits of human ability by harnessing knowledge to do what was previously impossible. They augment human insight and creativity with speed, power, and precision. Aided by computers, the factories orchestrated in a common goal. Every part and component is scheduled weeks in advance. Then the instantaneous comparison of project requirements with manufacturing actually creates a constant linear flow of work through the factory.

To appreciate the scope of this accomplishment, comprehend the immensity of an assembly line one mile long. It's so huge that if you painted the floor with a single paint brush, it would take five years. The product being manufactured here is so sophisticated that a defect no thicker than a sheet of paper could rip a supersonic airplane apart.

At one end of the plant are raw materials. At the other end a completed F-16 every 14 working hours.

How can you get from one end to the other, for the least amount of money, without sacrificing quality? Through the integrated computer aided manufacturing, we're able to track the raw materials from the time they enter the shop to the time they leave the shop as an airplane. The DNC is a very, very reliable computer system that stores information needed by the machine tools to cut parts. It distributes that cutting information down to each machine tool on demand and in turn picks up from the machine tool automatically the performance and status data about what the machine is doing.

How do you get hundreds of thousands of parts built and delivered to the precise location at the precise time for assembly?

One of the first decisions we made was that we wanted to go to a linear flow type operation for every part that was on the airplane where it was feasible to do so. The linear flow is taking a part and moving it from the warehouse area in the first cut on a machine tool with the least movement possible and having the part progress toward a finished part every time you move it.

How do you eliminate waste and expensive reworking? The big thrust has got to be through new technology, new methods, and new ways of doing things. We've just touched the top of that. The way we laid out the shop, we took fabrication discipline and that's where it's paying off because we can have flexibility.

How do you obtain accurate, up-to-date management information necessary for correct decisions? We do have an intricate computer system that allows us to match the actual hours expended against the standard hours earned on every part you work out there in the factory. We have a standards system set up in the computer which measures every increment of work in micro elements. Through that we are getting succinct performance data every day.

Integrated computer aided manufacturing works. It begins with the raw materials and continues throughout the manufacturing process. It channels parts through the numerical controls: sheet metal, chemical, composite cabling, and electrical.

By the way, the integrated computer aided manufacturing system constantly keeps track of every cost and meets every deadline.

The results stand out. To date, 39 percent of the aircraft delivered have been zero defect. Two have had absolutely perfect test scores, requiring no adjustments or repairs during flight. No other aerospace manufacturing facility in the world even compares.

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This F-16 program for me means that we're producing the top of the line, the best I have ever been associated with.

On the workmanship that we do, I wouldn't be afraid to ride in the airplane. Oh, I think it's great, it's fantastic.

In an innovative program using this factory as a spring board, new hardware and software, new methods and procedures are being disseminated throughout industry.

We feel that our airplane and our company will contribute very much to the efforts of peace in our country.

Integrated computer aided manufacturing. The cumulative impact is so great it will affect every American. It will boost the economy and the country, its ingenuity and innovation, its strength and vision, and above all its readiness.

A fantastic American product that will save the United States Air Force in excess of one-half billion dollars. That's productivity. That's the F-16 Fighting Falcon.

At General Dynamics, we believe in a strong America."

(Editor's Note: You can borrow the film, entitled "A Strong America," as well as other General Dynamics Corporation films. Direct your request to Mr. G. K. Burns, Chief of Photographic Services (Dept. 17-2), Mail Zone 6624, General Dynamics, P. O. Box 748, Fort Worth, Texas, 76101. Specify the date desired plus one alternate date. You may call Mr. Burns at 817/732-4811, Ext. 4177.)

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HIGH TECHNOLOGY INSTRUCTIONAL OPTIONS
BY CECIL L. GROVES*
AUSTIN COMMUNITY COLLEGE

A Look Ahead

Sometimes I like to engage in some personal science fiction - and pretend it's the 21st Century. What will life be like then? What will education be like then? Of course, others have done this before me. We have many futurists in our midst. But I don't like the scenario many of them are coming up with.

They tell us we will be associating more with machines than with people. They tell us we no longer will walk out into the dew-drenched yard to pick up our newspaper - that, instead, we will turn on our television set, where a list of top stories of the day will be rolling out. We will punch the ones we want to read, and printouts will come tumbling out of our television set.

We won't have to get the children ready for school, but each child will have his or her own video monitor and two-way talking machine. They will go to school in their own bedrooms - or maybe in the den - talking with a video teacher, if there are any questions.

My wife will have a home computer on which she will program the day's tasks for her trusty robot to perform (and, no, I'm not talking about myself). This robot will sweep and dust and perhaps even do windows. Meals will be cooked by microwave or laser and take no time at all.

When I read or think about a world like that, it makes me homesick for coal oil lamps and zink washtubs.

Already too often we are seeing people who are more comfortable with machines than with people. Families are disintegrating because the members don't talk with each other. How can they? The television set stands between them, with its talking heads and canned laughter and touchdown passes.

The worst-case scenario I have drawn is the pessimist's view. This look into the 21st Century doesn't have to be like this - and it won't be, if we use this marvelous new technology wisely and well.

I'm an optimist - you know the difference between a pessimist and an optimist, don't you? When an optimist takes a walk around the block, he expects to meet the love of his life; when a pessimist takes a walk around the block, he expects to be mugged.

Well, I'm an optimist - and I'm in love with the possibilities of the future, possibilities that can be made realities if we can use this great and expanding new technology to enhance our lives, to free us from our burdens and to draw us closer to others.

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*Dr. Cecil Groves is President, Austin Community College, Austin, Texas.

NOW...let's take another look into the future... this time to 1985, just three years from now. Let's pretend we are visiting a college of that time. What will we find?

I believe we will see students taking much more responsibility for their own learning. We will find students gathered in groups throughout the city - many different groups, but all looking at the same television instructor. Class discussions will conquer space, with students - wherever they are - able to ask questions and participate in the discussion.

We will see people learning at the work place and in their homes, earning college credit under the double supervision of their employer and an instructor.

We will see word processors as common as typewriters are now, and computer terminals as common as television sets are now. A vast amount of knowledge, now stored in libraries, may be called up with a flick of a button.

Work and education will be inextricably linked.

The technology for this kind of college, for this kind of education, is already available. It's now just a matter of getting it installed and putting it into operation. So the 21st Century can be here 15 years early for many of us.

Crossroads

I feel that education and the workplace, the two places which are most affected by the new technology, are the ones bearing the most responsibility now for choosing the correct paths to build the kind of world most of us want - where people can be productive and creative in their work, where they will have leisure to enjoy their families and their friends, where they can continue to learn and to grow so long as they live.

I believe we are at a crossroads now...that if we choose the best path now, the 21st Century and 1985 can't fail to bring fulfillment humankind has only dreamed about in the past.

With Robert Frost, we can say:

"Two roads diverged in a yellow wood,
and sorry I could not travel both
and be one traveler, long I stood
and looked down one as far as I could
to where it bent in the undergrowth..."

You might say that should we take the wrong road now, we can correct it later. Frost knew better, and we know better. Later in his poem, Frost acknowledged, "Yet knowing how way leads on to way, I doubted if I should ever come back."

Well, what is this crossroads we are facing in education as we consider the question, "High Technology: Its Impact on Education, Work and the Economy."

We in education, like our counterparts in industry, are taking our first tentative steps into high technology. And, believe me, the water's cold! There is so much of it, such a confusing and breathtaking array of technology applicable to education. Its promises are so lavish, its possibilities so immense.

Technology in education will spread rapidly once it gets started. Computer-managed instruction (CMI) and Instructional Television already have strong footholds. Technology also is having its way in many individual courses - typing is giving way to word processing, printing to an array of new and speedy developments, drafting - as I will discuss in some detail later - has a new face; in fact, no technical-occupation course can escape the technological waves that are stirring our world. Technology has already virtually consumed the work place, making it entirely different from just a few brief years ago.

For example, automation has taken over virtually every newspaper in the land. Computer terminals at every reporter's desk have helped reporters write more rapidly and with fewer errors.

Education can wait no longer to accept the challenge of the work place. WE MUST NOT WAIT to see what next year's technology will look like; we cannot wait for a new generation of computer or teaching device.

No, the demand for high technology in education is moving so fast that we cannot afford to wait. IT'S NOW OR NEVER.

We should move with confidence into this new area, heeding the passage from Corinthians, "For if the trumpet give an uncertain sound, who shall prepare for battle?" If those in leadership positions in colleges waffle about, trying to decide what to do, they will find their colleges far behind.

Myths

With technology in industry and in education moving at a rapid rate, the two areas are being drawn closer together; however, the merger and cooperation won't always be easy. Let me mention a few myths which have hindered cooperation between education and industry...

Myth One:	Educators and industrialists/businessmen have little in common - one lives in an ivory tower, the other in the real world.
Myth Two:	The Arts and Sciences (a broad and liberal education) are of no interest to industry and business.
Myth Three:	Industries are more efficient than educational institutions.
Myth Four:	The last and most insidious of the myths I wish to mention is that work and education are mutually exclusive activities.

Four myths, and many persons are so convinced they are true that they have stopped searching for other views, for the facts.

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Let me take these four myths one at a time, and talk about them and their implications for education and work in the 21st Century, and before.

Myth One; That educators and industrialists/businessmen have little in common. This may have been true at one time, but it's a long time gone. Even colleges know the importance of the marketplace. You will find this in business administration and engineering technology management programs around the country. At Austin Community College we are recruiting faculty who have had real-life experience in the subjects they teach. For example, a surveying instructor will have actual experience in the field; in fact, many of our instructors are full-time practitioners who teach part-time for us. I could have added another myth to the others - that those who can, do; those who can't, teach. Believe me, our teachers CAN DO.

We in public schools, community colleges, and technical institutes have always been involved closely with business and industry at the community level. Part of this has been the result of LOCAL institutions responsible to the communities in which we serve. Part of it has been caused by the provision in the Vocational Act that each technical-vocational program have a Citizens Advisory Committee, that is a group of PRACTITIONERS in the industry or business to interact with each program's instructors for two purposes - to see that the instruction is up-to-date and also to help place program graduates in jobs. This, along with a faculty directly working in industry - with one foot in the work place and the other in education - ensures a strong educational program.

More and more, academia and business and industry are talking to each other, and, I believe, both are the richer for it.

Myth Two: That industry and business are not interested in Arts and Sciences - is clearly what we have labeled it: a myth. Recently, Bill Flick, Vice-President of Operations for Lockheed Missiles and Space Company, emphasized that point in a talk before a group of Austin business and industrial leaders. Mr. Flick said he wouldn't think of locating an operation any place that didn't have a community college.

Why? It's not what you think. While Lockheed and Austin Community College have a number of employee-training programs we planned together, Mr. Flick says it's the wide array of Arts and Sciences classes that draws Lockheed's employees and their families into college courses.

"Most of our people have advanced degrees," he explains. "They have well-established habits of going to school. They enjoy it. What they learn outside their specialties makes them happier people..." Thus, they are happier in their work; they don't mind the adjustments to a new city and new environment.

Industry and business want persons who are educated, people who want to learn, who continue to grow, who can be promoted, and who will stay with the company, with desire for advancement.

There is nothing at all wrong with having an automobile mechanic who knows Shakespear or a welder who is acquainted with Plato. And we are finding more and more of these kinds of people.

Myth Three: That industries are more efficient than educational institutions. This is no longer the case, if it ever was. The same technologies used so well in management of private enterprise have been adopted by colleges. All of us who have to accomplish more with fewer dollars must be efficient. And that goes for both education and industry.

On the other hand, industry IS more efficient in producing products than is education. We aren't equipped, for example, to manufacture and distribute microcomputers. However, educational institutions are more efficient in education and training than is industry.

True efficiency comes when industry and education work together, with each doing what it does best, to form a partnership that is greater than the sum of its parts - industry enhancing education and education enhancing industry.

Now for the last myth I want to talk about - and perhaps the one I'd like most to lay to rest is that work and education are mutually exclusive enterprises.

This is no longer true - if it really ever was. There certainly was a time when trades and crafts were learned by doing, the apprenticeship system. Of course, when I and most of you were in college, our parents urged us to "get through with your education," then get a job. Well, that is no longer the case. Today when a child enters kindergarten, he may be living one day at a time, but he is likely to be in and out of some kind of formal education for the next 60 years...after that, he probably will be so used to education, he will take all kinds of informal classes. Many industries (notably Data General and Texas Instruments) build training time into each employee's work schedule. Virtually all work in our society is changing so rapidly that in order to stay up, every working person must move in and out of learning situations. He may enroll for credit in colleges, attend classes at his/her job site, or enroll in independent study by Computer-Managed Instruction or Instructional Television.

The Industrial world has been stampeding into Texas during recent years. One of the incentives - in addition to weather and an attractive life style - is the available labor pool. But in most cases these prospective production workers need training. At Austin Community College, we have been and are heavily involved in an array of different services for industry. For example, the college is a pioneer in the field of Industrial Start-up Training in Texas. The first program of this type in the state was developed by members of ACC staff and from years of experience they have distilled a system of programs made up of the following components:

- Work preparation (Orientation, Pre-vocational Training).
- Specialized Job Training (Industrial Start-Up, Adult Vocational Training, Occupational Education courses).
- Employee Development (College credit, workshops, seminars, conferences).
- Employee Assessment (Credit for industrial-based training, employee

testing).

* Cooperative Education (College credit students).

Training programs are planned jointly by the college and the sponsoring employer to meet the specific needs and objectives of the employer.

Technical instructors can be supplied by the college. Often, however, the best choice of instructors for the company, particularly in the Industrial Start-Up Training, is its own highly trained experts.

ACC develops the curriculum, meeting both the company's requirements and the regulations of the Texas Education Agency (TEA), the funding agency. Companies that are developing new plants or expanding existing ones find the Work Preparation and Specialized Job Training portions of the ACC system fit their needs. For retraining or upgrading of employee skills, Employee Development programs are used. And for "quality of life" and improvement of employee relations, a company would want to select from Professional Development programs.

The College offers other valuable related services to business and industry, such as Adult Basic Education (ABE), English as a Second Language (ESL), manpower planning assistance, employee assessment and management consulting services.

A recent addition to our offerings has been the teaching of Electronics (AC and DC Circuits) by Instructional Television using cable. The vocationally related courses offered by ITV include Magnetism and DC Circuits, Air Circuits, and Combination Magnetism and DC and AC Circuits. Offering these courses by television gives workers an opportunity to take the courses without losing work time. An efficient, cost-effective system for training workers is a necessary part of developing a dependable source of workers.

Examples Of Industry/Education Ties

For example, with Advanced Micro Devices, Austin Community College has provided Entry-Level Workers Training and Industrial Start-Up Training; with Motorola, Texas Instruments, Data General, American Bank, Austin National Bank, CarboMedics, Houston Instruments, Jack Brown Cleaners, Texas Commerce Bank and Stripling-Blake, we have provided Employee Development Training; with Art Carved, Motorola, Texas Instruments and CarboMedics, we have operated Handicapped Workers Training Programs.

While Austin Community College for several years has had working arrangements with local industries for training employees of those industries on site, we are only recently developing the kinds of trust and confidence in which these industries open their facilities to all college students, not just to their own employees. In addition, the College has received, in the last six months, well over one-half million dollars in equipment donations from industry, with more anticipated. If we included space provided free as well as use of equipment, the total resources provided the College would well exceed a million dollars. For example, in a major breakthrough, Bausch & Lomb, Inc., has served as a trailblazer in such a program of cooperation with the College.

Bausch & Lomb manufactures electronic tools for drafters - tools which promise to revolutionize the entire drafting function. Bausch & Lomb offered space and equipment for ACC students - 24 to begin with - have access to equipment worth more than a quarter of a million dollars. Our students are in on the ground floor in the use of five different systems of drafting tools. One of these electronic tools can replace traditional tools such as scales, templates, rub-ons, and the drafting table.

Bausch & Lomb uses this sophisticated equipment during the day to demonstrate it to customers; in the evening hours, ACC students can learn to use it. Another plus for the students: If they show high proficiency in electronics drafting, Bausch & Lomb is likely to offer them employment.

ACC has an arrangement with Lockheed Missiles and Space Company similar to that with Bausch & Lomb. As a recent addition to the Austin industrial community, Lockheed encouraged the College to conduct classes in quality control and quality assurance, data processing and industrial technology using Lockheed facilities and equipment. They have also donated equipment and provided consultation for the development of new occupational programs. In addition, key Lockheed officials (including the vice-president of operations) serve as College faculty.

The latest of our cooperative efforts with industry is a contract with IBM to, again, use IBM's donated equipment in space provided by IBM to train industrial service technicians who will work on automated equipment systems. This is truly an exemplary program which promises to open a new area of technical training. At night, like at Lockheed and Bausch & Lomb, IBM, Tracor and Automated Products, Inc. make space available for ACC students other than their own employees.

It is obvious that these arrangements with industry are of tremendous worth and benefit to our College in many ways. Besides equipment donations, other values the College receives include additional instructional space, part-time faculty members from those industries, a source of Advisory Committee members who help the College relate its instruction to job opportunities, a source of cooperative education opportunities, and the vehicle to improve the College's image in the community through work with community and industrial leaders.

But there are significant benefits to the industries, too. It does little good to invest in computers, numerically controlled machines, tools or other complicated devices unless the skilled work-force is available to operate and maintain them. Unskilled or untrained workers operating expensive equipment in today's high technology era could result in tremendous financial losses in damages, accidents or down time.

The American Management Association has put a money figure on this. The AMA estimates that the annual output of the American economy could increase by $100 BILLION dollars if we could only get the right workers in the right jobs.

Our friends in industry tell us that they see training and education as a means to solve problems of employee turnover and growth both in employee numbers and technology. The program may include an initial orientation to a task; retraining when the job function changes or when new equipment is installed, or a new product or system is introduced; new training when an employee shifts positions; replacement or initial training when a new employee comes on board.

Guidelines

Here are some guidelines that have worked for Austin Community College while forming cooperative education and training programs with industry. Perhaps some of our fellow institutions - public schools, technical institutes and other community colleges - will find them useful.

Following are a baker's dozen guidelines that I'd like to share with you.

1. Establish an Advisory Council/Committee of key individual employees for the purpose of sharing concerns and ideas and to learn what programs and courses employees need.

2. Develop mutual trust. There is nothing more important than this. Without it, the cause is lost.

3. Develop networking. The College official cannot stay in his office he must get out and get acquainted with the industrial people in the community. There is little sharing of information between companies at the operations level. The College can be a "safe" conduit for sharing.

4. Assign only one contact person with each business/industry. All of you know the dangers of different messages carried by different messengers. If possible, the contact person should be assigned full-time to work with industry and have the time, intuition and motivation to be successful - in addition to having the relevant technical skills.

5. Be patient. Patience means don't give up. If you can't work out something, try again in a few months. Sometimes it takes years to work out a cooperative program.

6. Continuous communication. I believe weekly communication between a college-school contact person and the industry counterpart is essential. Any problems that arise can be confronted and solved before they become large.

7. Offer suggestions. Don't wait for industry to take the initiative. Colleges/schools should have a plan, but be ready to change it through conversations and discussions of need.

8. Don't forget that every industry's needs are a little different.

9. Respond quickly to proposals from industry, and respond with an understandable answer: Yes or No. One caution: While there are many mutual interests of education and industry, education cannot afford to undertake a task of training that would water down its standards; that is, a college, technical institute or high school cannot afford to give credentials away.

10. Follow through. Once a cooperative agreement is reached, finish the action. Do what you said you would do - and do it well.

11. Remember, the stakes are high. If it works, you win big; if it doesn't work, you lose big. Once you mess up, it's a real problem and you may never recoup.

12 Keep in mind that little things usually make the difference. That's why regular communication is so important - you learn the little things that are important to the industry.

13. Don't forget to give credit to others. This is not an area for educators' egos. Let the recognition go to the industry personnel, they have supervisors, also.

Schools, colleges and institutes will develop their own high technology - the use of computers in instruction, cable television with dedicated channels for education, word processors, two-way hookups for exchange of information, dozens of new developments occurring almost daily. Even so, the best hope for educational institutions to move into high technological instruction is through partnership with industry. We cannot fail to seize the day...seize this great opportunity.

Many of us have heard our fathers say, "I can do anything that any other person can do." They were speaking, of course, in a time and place where people did everything - from building their own homes to shoeing their own horses, to repairing their own cars. Suddenly, the world got away from them. High technology made doing things more difficult and easier - all at the same time. What it really did was place us in the hands of specialists. Now high technology is enabling us again to take hold of our own destinies. The same technology that made man ineffectual can be used - in instruction - to bring back his powers to be in charge of his environment again.

Dale Parnell, executive director of the American Association of Community and Junior Colleges, predicts that "community based colleges are the wave of the future in higher education, particularly if they tie into the local cable systems and specialized TV networks to provide expanded services in programs." He says the telecommunications revolution with inexpensive video recording techniques - cassettes and discs - allow us to replace instructional programming in public libraries, factories, prisons, apartments, buildings, wherever people are.

Dr. Parnell predicts four major positive shifts in education over the next twenty-five years, all motivated by new developments and technology. They are;

(1) Open access to learning, with elimination of the barriers that have closed many doors - financial, cultural and social.

(2) A change from education for all, to education for each. The new technology assures that the future of education will be individualized, with self-pacing individualized learning contracts, new academic calendars, and personalized graduation ceremonies.

(3) The emphasis will change to what is to be learned. Previously, the emphasis was on what is to be taught.

(4) Increased emphasis on cooperative, consortial and collaborative efforts - the kinds of cooperative ventures we have been discussing today.

The community college/technical institute/public school, because of their natures are dedicated to good teaching, and as local institutions interested in local problems, can be the midwife for this new technology which will return our world to a manageable way of life, to a place where individuality is nurtured and where each person is important and master of his world.

HIGH TECHNOLOGY AND THE ECONOMY
BY GENE BOTTOMS*
AMERICAN VOCATIONAL ASSOCIATION

My remarks will center around four points. What is high technology? Why all the hurrah about it? What are its implications, at least in terms of education? Then lastly, I will discuss current legislative initiatives while indicating the activities that will probably receive more attention in the new Congress in 1983.

A conversation that I had with a gentleman last evening on the airplane while en route to Texas illustrates why you are having this conference.

He is the vice president of a telephone communications firm, based in Dallas. His company did not exist three years ago. Today, that company has 800 employees and does a $100 million plus business a year. His company already operates in the black and is planning expansion to the East and West Coasts as well as the Southeast.

I asked him where his company hurts the most with regard to workers. He said, "technicians. We can't get enough."

The needs of that telephone communications firm typifies only one small part of a very large high technology movement that's taking place in America.

As I get started, I'd like to introduce Dan Hull, who heads up a curriculum development effort here in Texas. When I first started trying to find someone in this country who really knows what high technology is all about, people kept telling me I ought to get to know Dan Hull in Texas (Information about Dan Hull and his curriculum development center appears at the end of this speech).

High Technology

As you look across this country, you find that some folks have been into high technology for 20 years. Other folks have been struggling at it for five years and have just gotten a little piece of it nailed down.

High technology is an area that's not very well defined. It's certainly going to bring a change in the process of production. It's going to create a different mix in terms of labor, materials and energy. It will result in increased productivity. It's something that changes very rapidly.

Computers are a major part of high technology, which creates the need for workers who not only know how but also why.

High technology is transferring information rapidly. It's smaller devices doing more things, using fewer and better types of materials.

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*Dr. Gene Bottoms is Executive Director, American Vocational Association, Arlington, Virginia.

Now all these things that I've mentioned are a part of high technology. But it's hard to nail down.

High technology is not all new. Part of it in America is catching up with what the Europeans have known as good quality vocational-technical education for years. We've just never quite been able to put it forth in this country.

Now high technology is not completely predictable nor is it just merely computer games. It's a lot more than that.

High technology is certainly going to alter the human skills that adults need in the workplace. I suspect it's going to alter work organizations.

The September issue of Scientific America sets forth a number of themes which indicate that high technology is an extension of a mechanization that's been taking place for 100 years in the workplace of America. It's a continuation of that extension.

Take agriculture, for example. It's not necessarily the thought of mechanization, but it's the application of genetic engineering.

In commerce, it is transportation, packaging, and scheduling with a computer. With banking, it's a whole different system of handling money and record keeping, etc. With the office, they talk about the word processor becoming the mainstay of office systems.

In manufacturing, it's a combination of systems beginning to come together. In health, the computer makes it possible to trust less to the doctor's memory for diagnostic purposes.

Read the September issue of Scientific America. It helps you see high technology as a continuing evolution. It touches on the different industries.

Most of high technology is often used in the context of computer science, or biological engineering, or electronics, or electrographics, or energy, or material changes. Then there's a whole miscellaneous grouping that you could add.

You grab a hold of one part of high technology and you think you've gotten a corner on the market. It's pretty pervasive in cutting across a broad spectrum of work.

In California, efforts were made to try to boil high technology down to about five areas in a major study that was conducted. The five areas were: communications/information; automation; energy and new materials; agriculture; and biological engineering.

High technology does increase our ability to control the universe. When I was at the World's Fair in Knoxville this past summer, I visited the "Home of the Future." I discovered that high technology is going to revolutionize the role of homemaking.

High technology is hard to nail down. I predict that we will spend the better part of this decade sorting it out.

Change is very rapid. Talk to employers in the workplace who have been involved in high technology. They hire engineers the first time around to implement innovations. The next time around they want technicians. We're still very much at that sorting out processing.

Why The Hurrah?

Why all the hurrah about high technology? There are several reasons to consider.

We have a sluggish productivity growth rate. From 1948-58, our economy grew at about 3 percent a year. From 1974-81, we grew only about .7 of a percent.

The capital ($$$) to labor ratio in the U.S. has remained constant over the last decade. An economist, appearing on Meet the Press just last week, stressed that as long as we don't increase our investment in improving technology for the worker in the workplace, our productivity is not going to go up.

When you compare the U.S. with other industrialized countries, we fell from 1st to 6th place during the past decade in the ratio of capital investment per worker. Western Europe and Japan have more capital investment per worker. Western Europe and Japan have mor capital investment per worker.

If you just isolate the "office setting," the ratio of capital investment to workers has not changed over the last 30 years in the U.S.

In the area of foreign trade, the U.S. now imports more than it exports. We have lost our share of the world market place in over 17 of the top export commodities.

Look at the percent of skilled workers in the labor force. We have dropped from 2nd to 7th. We fell from 29 percent to 26 percent of our work force that is classified as skilled. There are six countries which have a higher portion of their work force that is skilled.

Since 1975, the U.S. has placed close to last in almost every category of competition in the VICA International Skill Olympics. We normally compete against 15-20 industrial countries.

Historically, this country has gotten its advanced level of skilled workers through immigration. The U.S. has never conceptualized a system for producing advanced level skilled workers. In fact, we kind of felt like automation would solve all of our problems.

Whether I visit a nuclear power plant or a steel plant in this country, I find corporate leadership resolving that no longer can they solve the productivity problem just with advanced technology.

With advanced technology comes great complications. You must have a worker who understands or possesses a broad spectrum of knowledge.

The Japanese spend much more time than we do in producing an advanced level of skilled workers who have a much broader picture of what's going on and understand where they fit into the picture. They have much better utility in terms of moving from one kind of job to another. That means a much broader base, much better preparation, and a much longer period of preparation.

Shortage Of Workers

High technology means that we do have a shortage of advanced level skilled workers in America. That's not unusual.

For a decade, our national policies have been linked with the welfare structure, and not with the requirements of the workplace.

From 1960-80, the U.S. has not changed the proportion of students enrolled in engineering technology programs. In 1960, it was 4 percent. In 1980, it was 4 percent. Engineering technology programs grew out of the 1957 National Defense Education Act (NDEA).

As I visit community colleges across the country, I notice they have had big enrollment increases, but most of it has not been in the engineering technologies. They haven't had the dollars to move into the engineering technologies unless they've been innovative.

High technology does mean that we must experience a growth in enrollments in engineering technology programs.

Implications

What are the implications of high technology? I spent two days this past week at a nuclear power plant that will be opening up in Northeastern Pennsylvania. At this plant, they are looking at their entire work force. What it means to them is an increase in the number of advanced level technical skilled workers that are needed.

It's still too early to tell how many new workers high technology will require. You might look at the recent issue of Future's Magazine which contains some projections.

We don't know if high technology means a decrease in the number of moderately prepared workers. Some folks say that increased technology means that most people won't need much preparation, but that there will be an expansion of advanced level skilled workers needed by industry.

We do know that there is an increasing demand for advanced level technical skilled people across the entire occupational arena.

What implications will this have? We have to look at some kind of super tech curriculum for high technology. It will be systems oriented, developing a combination of skills in such areas as electrical, mechanical, fluids, thermal, optical, and microcomputers. It will have a strong technical base, and allow people the capability to continue to learn as the technology changes.

It might mean doing what's being done in Greenville, South Carolina, and in Portland, Maine.

The local industries have told the secondary and post-secondary vocational-technical programs that they are not producing the advanced level technical skilled workers needed.

What industry needs is a four-year curriculum, with the last two years of high school and the 13-14th grades being locked together into a four-year pattern. Industry doesn't want everyone to go through the curriculum. Industry wants the brightest minds in vocational-technical education to go through the curriculum.

Industry will be the third leg of the curriculum, whereby the students get planned and sequential experience in the workplace. Industry is willing to select the students up front and put them on the payroll partially as they begin to move through the four-year pattern.

What's being done in Greenville and Portland is the European concept, which states that you've got to have a system for training advanced level skilled workers. In this nation, we have no such system.

The U.S. has about 300,000 people in apprenticeship programs. Germany, a nation one-fourth our size, has far more than that.

What it comes down to is this. Instead of just having 6 million students enrolled in occupational specific programs in America, we will have to determine a way of finding the brightest minds out of those 6 million, and produce a million of them at the advanced level. This may mean a new kind of relationship between secondary and post-secondary education.

Another option to meet industry's needs might come down to short-term programs similar to what's being done in Massachusetts.

Private institutions have developed programs, 9-12 months in duration, and are taking school teachers, who couldn't get jobs because of declining enrollments, and preparing them for high technology careers. The programs, to some extent, are geared to teachers with science and math backgrounds. It's a successful effort. Our community colleges need to be doing this.

Many employers can't wait for a four-year curriculum. They hurt for workers right now. Thus, you have to have short-term as well as long-term programs.

In part, high technology is going to expand our vision of what the quality of vocational-technology education is all about. As the Europeans have known, it takes time to produce a journeyman level person. It cannot be done in two years. It's going to take time. That's one concept we must look at.

As a second implication, I see a greater integration of technical knowledge and systems in the workplace.

Look at the industrial office, for example. Employers are hiring individuals who have across-the-board knowledge and skills. In other words, they can handle accounts receivable, answer phone calls regarding accounts, process renewals, and handle marketing functions. Employers are looking for workers who have much more knowledge.

That's one illustration of how a person has to be better prepared across several disciplines. The same holds true for workers entering the engineering, mechanical, and electrical trades.

An increasing knowledge of math, science, and technical understanding is going to be a large part of curriculum revision. To some extent, it's redesigning the structure and content of existing curriculums. Sometimes it may mean new programs.

Curriculum Models

I have not found anyone who has really sorted out clear curriculum design models for the secondary and post-secondary levels.

I am hopeful that in the next 18 months the AVA can at least pull together what we've learned from the field in terms of what many of you are doing. Hopefully, some clear understandings will begin to emerge.

It will mean a better grounding in math, science, and communications skills. However, I'm not sure it's going to mean teaching those subjects in the abstract. I think they must be taught in connection to a broad occupational objective.

There are a lot of examples in America of outstanding vocational education programs.

There are specialized high schools in New York City, for example, where math, science, and technical programs are integrated very well. There is a long waiting list of students wanting to get into vocational education in those high schools.

Many community colleges have been able to bring about such an integration of disciplines.

Physics is very much a part of engineering technology. In some community colleges, the physics teacher is much more a member of the engineering technology faculty than of the science faculty.

High technology requires a better grounding in the basics. The National Science Institution states that "if we are going to upgrade the productivity of American workers, we'll have to upgrade the productivity of the average worker." That can only be done through vocational [illegible]hnical education.

The best way to teach science and its principles is to show its application in the occupational context. That has implications as we think about school organizations.

There will be broader technical knowledge in applications. As one thinks about the mechanical, electrical, and engineering technology trades, as well as the information sciences, I think there are some things we can begin to identify that we can make changes in at both the secondary and post-secondary levels.

People/Jobs Mismatch

Thirdly, I think that high technology has implications for an expanding mismatch between people and jobs.

You are going to increasingly have employers bidding against each other for the scarce supply of advanced level technical skilled workers. At the same time, we are going to run at 8 and 9 percent unemployment in this country during this decade. We'll have mismatches.

Major competition for workers among companies has been going on for some time, but it will escalate.

Vocational-technical education must come up with both short-and long-term strategies to address this problem. It will require some expansion of programs.

Recently, I was at a three-campus community college system in Sacramento, California. They have 150 percent more folks applying for the electronics curriculum than they can serve. Their capacity to meet the demand is just not there. They are operating on a two-a-day shift now.

What we have not done in vocational-technical education is to expand our program capacity in some of the high technology areas where we're going to have great demand. We must search for ways of doing that.

Sorting Out

Fourthly, there is an implication for sorting out the applications of high technology.

We don't yet understand completely the interplay of people in technology.

I have found that the institutions attempting to upgrade their program in a high tech area have a commonality. They have done so with a consortium of private employers.

Usually, they will designate a faculty member as a continuing contact person. If it's an engineering technology program, it might well be a faculty member from the engineering department or college.

There are numerous examples of successful high technology programs in colleges across the country. Write me at AVA for a list of the speakers who were asked to share their high tech experiences at a workshop scheduled just prior to the start of the 1982 AVA Convention in St. Louis.

The institutions they represent have made substantial changes in programs. They have much to share in terms of how the curriculums were changed, and how equipment needs were identified and selections made. They can also relate how they have worked with employers.

Telecommunications is one area that is up and coming. In California, 10 companies in that field provided $150,000 for the development of a telecommunications curriculum. Those 10 companies worked with a consortium of six community colleges.

I have found that you almost have to tie to the private sector in a consortium effort to do this job, and to sort through it.

Social Innovations

The last implication I see is that anytime you interject new technology into the workplace, you create implications for social innovations in the workplace. New approaches.

The integration of technology and knowledge means that people are going to have to know more about what other people do. The whole issue of quality services and the various teaming approaches is going to be critical.

If you have read about Three Mile Island, you get the notion they didn't have skilled workers who could understand the implications of certain things taking place.

There must be much more of a participatory kind of team effort in the workplace, and a sharing of knowledge. It's certainly going to create some social innovations.

This conference has touched on private sector initiatives and foundations. I'm not sure what all they will be. We're very innovative in America.

It may mean creating some social innovations in the education setting.

A few years ago, I had the privilege to help plan a new high school. We decided to plan the high school with no traditional departments. There would be no science, English, or social studies wings.

Basically, we designed the high school around occupational clusters. A chairman was named for each cluster. Your science and math teachers, and so forth, were made an integrated part of the clusters.

If high technology means acquiring a higher level of understanding of math, science, and communication skills, then we must look at and explore new kinds of educational structures as well. It is time to put the practical and the academic curriculums on the same track.

Legislative Arena

I would like to focus briefly on the federal legislative arena, mentioning first what's presently happening on Capitol Hill. I'll then talk about what we might expect from the new congress when it convenes in 1983.

Several bills have been introduced that relate to high technology:

.one proposal would target \$1.2 billion over a three-year period on math, science, computer language, and vocational education programs. Thirty percent would be earmarked for vocational education for use in high tech areas.

.another proposal would allocate $500 million over a five-year period to prepare math and science teachers and technicians, with particular focus at the post-secondary level.

.formation of a quasi-federal council, to give leadership to science education and the need for high tech people in this nation, is the thrust of another legislative proposal.

.another bill introduced should upgrade course offerings requiring computer knowledge in the high tech area. That proposal is called the American Defense Education Act.

.providing tax credits to employers who assist school systems in upgrading math and science teaching is the thrust of yet another bill.

.Texas Senator Lloyd Bentsen has proposed a Scientific and Technical Equipment Act that would grant tax credits to employers that donate state-of-the-art equipment to secondary and post-secondary vocational programs, particularly in critical new fields.

As you can see, there have been numerous bills introduced that relate to high technology. It remains to be seen how many, if any, will make it through the congress.

Most of these bills encourage public institutions and local employers to work together with a minimum of government interference.

I encourage you to make contact with Senator Bentsen and your Congressional Delegation from Texas and indicate how important it is that some type of legislation be passed that will provide both funds and tax credits within the realm of high technology.

It might well be easier to get a scientific and technical equipment bill passed that will help to re-equip our vocational-technical programs, than it would be to get a specific increase in vocational-technical funding.

If legislation cannot be passed during the lame duck session, then we must work with the Senator and others over the next two years to make sure that some type of high tech legislation is passed. This will be a major legislative objective of the AVA. We are organizing a grassroots effort in that regard.

What could happen next year with the new Congress? We could see a new National Defense Education Act.

It is possible there could be an omnibus piece of education legislation passed next year, focusing on math and science. It could contain the reauthorization of vocational education, with a major focus being the use of federal dollars to upgrade the scientific and technical literacy base of vocational education.

Conclusion

When most of this nation's governors come together for a meeting, they talk quite a lot about high technology.

They are concerned that as a nation which leads the world in Nobel prizes, we have gradually lost the leadership in inventions.

A scientist from IBM, speaking at a recent meeting I attended, nailed down the role of vocational-technical education.

He said the reason that America has lost ground in inventions, application of knowledge, and in new products to process, is because we have not paid enough attention to producing an adequate level of skilled workers and technicians.

The improvement of products at IBM comes not only from the research laboratory, but it also comes from the skilled worker who uses the product and services it.

There's a lot of talk about the private sector spending $40 billion a year for training. A close look reveals that most of this in the past has gone for the training of executives and people in marketing and sales. Few dollars have been spent by private industry on the technical and skilled worker.

I see nothing but opportunities for vocational-technical education to work with the private sector. There is an opportunity for secondary and post-secondary vocational-technical education to develop a four-year curriculum in collaboration with your local industry leaders to produce those advanced level skilled workers this nation needs.

America hurts today because of a shortage of advanced level technical and skilled workers. This problem will get worse before it gets better.

Thank-you.

(Editor's Note: In his speech, Dr. Bottom's makes reference to Dr. Dan Hull, President, Center for Occupational Research & Development (CORD), 601 Lake Air, Waco, Texas 76710. (817) 772-8756. CORD is an independent, non-profit organization established in 1979 to conduct research, develop curriculum materials, and disseminate programs and courses for high technology areas. You might contact Dan Hull for additional information on high technology and the activities of CORD).

CONFERENCE IMPLICATIONS/CHALLENGES
BY BEVINGTON REED*

Ladies and gentlemen, it may be significant that among all of these scientists and engineers, that a person who's major field is literature and history and who is currently instructing a class in the writing of poetry, has been asked to evaluate what has been said here the past two days.

This conference has been an eye opener for me. I've been so amazed and inspired by the wonderful presentations that have been made, and by the sense of exchange between our leaders from education and industry.

I would be remiss if I didn't commend the members and staff of the Advisory Council for Technical-Vocational Education in Texas for putting together one of the best programs that I have seen in my more than 40 years of work in education. In fact, this conference has made me wish I were young again and ready to tie into some of these challenges and problems.

National Education Policy

The results of this conference point to the need for a national policy on education, of employment and training, of defense and human resources. Such a policy must recognize the needs of both the industry and education sectors, including their capabilities and limitations, and tie the two together.

Awhile back, I sat with a group of people who were trying to do some planning on what was going to happen to many of our institutions when enrollments declined. We conveyed to the Secretary of Health, Education, and Welfare, as the position was called at that time, about the necessity for some sort of a national program for education.

The HEW Secretary didn't want to commit the Administration to a national program because such a program would require financial support.

Because there is no national program or policy base for education, we have fragmentation -- a despersion of effort -- resulting in too many mediocre programs and not enough A-1 programs. We have too many programs in some areas and not enough in others.

Within vocational-technical education, we may still be training people for the types of activities that are going to be out-of-date tomorrow.

Implication For Change

The implication of all these presentations is that we are living in a time of unprecedented change.

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*Dr. Bevington Reed is Commissioner of Higher Education-Emeritus, Coordinating Board, Texas College and University System, Austin, Texas.

Change often threatens people. Unless we can reassure ourselves that change is for the better, we are only going to be halfway successful in responding to the needs of business and industry as well as to the needs of individuals. This is true in vocational-technical education. It's true in higher education. It's true in research, or anything else.

The one thing that I've heard over-and-over again at this conference is change -- immediate and continued change -- necessitating the frequent re-education of not only workers but also the people who are going to be the teachers.

Business and industry can tell us what their needs are going to be. We in education can tell them what our capabilities are. We can make the needs and capabilities meet if we can sit down and talk together.

Computer Education

I have been reading about computer education in the elementary school, and how much faster students learn math and reading through the use of these machines. These little kids are taking to computers like ducks take to water.

Computers have implications for vocational-technical educators. They have a great deal of implications as far as the public schools are concerned. There must be some basic changes in elementary and secondary education. That means there must be teachers who are comfortable talking about and using computers.

There are very few teacher education programs, including those in vocational-technical education, that give the people, who are going to be instructors in elementary and secondary education, an opportunity to experiment with the high tech machines that are available to them. That's a tragedy.

Now I don't know what you can do about it, but you ought to talk about it a little bit. One of the implications of this would be that there has to be some more money put into some of these programs.

Put The Money Where The Future Is

If high technology is where our future is -- in terms of job opportunities and instructional resources -- then we'd better put our money where our future is.

And once again, there is an urgent need for cooperation between our educational institutions and the high tech industries. Let us also not forget the low technology, if there is such a thing, and the jobs that are being displaced and the workers which must be retrained.

But of all things, what we are really talking about is change. For the people in the high technology industries, tomorrow happened the day before yesterday. Thank-you.

WHAT OTHERS ARE SAYING
ABOUT HIGH TECHNOLOGY, EDUCATION AND THE ECONOMY

The following are highlights of what other leaders from industry, government and education are saying with regard to high technology, education and the economy.

The comments appearing in this section were gathered from three sources: (1) attendance at national high technology and vocational education conferences; (2) a series of articles on "Texas: As the Oil Runs Out," which appeared in the Dallas Morning News, December 19-23, 1982, as written by reporters Barbara Johnson and Polly Ross Hughes; and (3) subscription to "Business Industry Demand Information for Vocational Education," published by Sauk Hill Publications, Inc., Madison, Wisconsin.

"The five-ton computer of the 1950s is now the size of a wristwatch, making technological advances lightening quick. We live in an information age where there will be more knowledge in the next 10 years than the previous 10 centuries."

--Thomas Miller, Vice President, Business Development
Control Data Corporation
Minneapolis, Minnesota

"The computer is the 'leading edge' of technological advances in industry. Everything about a product -- design, analysis (engineering), drafting and documentation -- can now be done on a computer before it's ever manufactured. The prototype or 'model shop' environment is becoming a thing of the past."

--Jane Frederick, Executive
Mead Digital Systems
Dayton, Ohio

"By the year 2000, based on White House Advisory Committee Social Indicators, a mere 2 percent of the work force will be involved in agriculture; 22 percent will be in manufacturing; two-thirds will be allied in information occupations; another 10 percent will be in service jobs."

--Richard Krigbaum, Futurist
Wheaton College
Wheaton, Illinois

"High technology is changing the 3 R's to mean: retrain, relocate or retire. Robots currently in place have the potential to displace 855,000 workers by the 1990s, with advanced robots possibly displacing another 2.1 million. For every four workers displaced by a robot, .8 of a job is created, with the new jobs being in the maintenance and programming areas."

--James Rehg, Director, Robotics Center
Piedmont Technical College
Greenwood, South Carolina

"There are 17 million electronic typewriters in use in this country. They will not exist in the 1990s except perhaps in the classroom for teaching keyboard. Electronic typewriters are going to be replaced by word processors. Two million word processors have already been installed in the U.S. Over 5 million will be in place by 1985. There will be 17.5 million work stations with word processing capabilities by 1990."

--Steve Hansen, Sales and Training
Lanier Business Products
Atlanta, Georgia

"The Office of Technological Assessment predicts the need for 150,00 technicians in microbiology by the end of this century."

--David Winter, Director, Medical Research
Sandoz Corporation
East Landover, New Jersey

"Electrical and electronic maintenance people will constitute the biggest skilled labor shortage in the manufacturing industry. Vocational education can provide much of the training. Workers must be well grounded in communication skills, reading, math, and physics. The most vital link between the schools and industry are cooperation, understanding and communication, which can best be achieved through advisory committees."

--Richard Gumbel, Manager, Apprentice and Technical Training
Caterpillar Tractor Company
Peoria, Illinois

"Today's banking is largely electronic fund transfer and automated teller machines. We need workers who can add and subtract, and who understand smaller computer systems - not the micro computers like the Apple and IBM personal computers - but the smaller scale computers sold by IBM, Burroughs, and NCR."

--James Maholic, Manager, Information Services
Citizens Industrial Financing Corporation
Morgantown, West Virginia

"The shortage of skilled machinists and toolmakers is now 60,000 and will be 250,000 by 1985. The nation is presently training only 5 percent of the number it will need over the next 10 years. By 1990, American industry will need an additional 11,000 drafters, 23,000 engineering technicians and 58,000 machine service technicians. Even when conservative estimates are used, the projected number of highly specialized technicians needed by 1990 comes to 4.2 million. About 2 million can be prepared with the capacity of existing vocational-technical programs."

--Gene Bottoms, Executive Director
American Vocational Association
Arlington, Virginia

"About half of the 350,000 people now on lay-off will never return to the automobile industry as such. New technology, robotics, and just modernization are going to eliminate jobs. We are going to be a service nation rather than a manufacturing and industrial based nation. The industrial base of this country is manufacturing and there is all kinds of evidence that we have done nothing to protect it from other countries."

--Arthur Shy, Director of Education
United Auto Worker's
Detroit, Michigan

"More people should be encouraged to obtain a basic liberal arts education preceding specialization. Students should develop entrepreneurial skills. The auto industry has a tremendous need for mechanics. America must keep its basic manufacturing industries. Diesel and gasoline engines will exist through the next 20 years. Computer aided design/manufacturing are major developments in the auto industry."

--Baron Bates, Vice President, Public Relations
Chrysler Corporation
Highland Park, Michigan

"The machine tool industry is very interested in getting its productivity edge back against foreign competition. High technology is the key. Machines are going to become essentially Numerically Controlled (NC), creating demands for managers of machine centers, programmers, and electronic maintenance people. The urgent need for vocational-technical schools is the upgrading of equipment and for instructors to keep up-to-date on current technology so they can modify their curriculum. Schools must solicit industry advice. Vocational schools must offer training in NC. A good basic background in math and science is important."

--John Mandal, Director
National Machine Tool Builders Association
McLean, Virginia

"A person starting out in a skilled trade -- say a machinist or a lathe operator or a milling machinist -- would have a better long-term potential of making a good living than someone going into an administrative area. Improving cooperation and communication between vocational-technical education and business and industry has to be an impartial third party approach -- perhaps a chamber of commerce that has both members from education and industry. Young people going into the machinist trades, etc., certainly should get some computerized training."

--Jack Finch, Vice President, Industrial Relations
Burgmaster Division, Houdaille Industries, Inc.
Los Angeles, California

"American business and industry is losing its edge in manufacturing to other countries. We are losing our edge in productivity. We foresee a shortage in skilled process operators, people who can operate complex food compounding equipment, spray driers, and related equipment. In the food industry, there is a demand for data processors, food scientists, nutritionists, and chemists. To fill the gap, we must modernize our thinking with organized labor, changing current procedures of apprenticeship programs where we can work with career centers or vocational schools."

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--Gordan Small, General Personnel Manager
Wyeth Laboratories
Mason, Michigan

"A combination attack is the best way to prepare a skilled work force. Industry should hire young people right out of voc-tech school as trainees and then provide in-plant, on-the-job-training. The most vital link between the schools and industry is start-up training. Business, industry, and voc ed could improve cooperation and communication through a joint training committee. Electrical maintenance and mechanical maintenance personnel are going to be in short supply in the lumber industry."

--James Young, Director
Georgia Pacific Corporation
Crossett, Arkansas

"The strongest single link between schools and business and industry is through the industry-trade organizations because the organizations reflect the needs of their members. Many instructors are still teaching from textbooks written 15-20 years ago. America must renew its pioneering spirit."

--Robert Shanklen, Executive Vice President
Home Guarantee Insurance Corporation
Richmond, Virginia

Texas good fortune in the petroleum business is "distracting us from what we ought to be doing in Texas right now. We aren't preparing ourselves for the sunrise industries. We ought to have very agressive leadership in Austin that makes a major investment in building the human capital base that can support new technology, new enterprise. If this country is moving to an information society, Texas better get with it. And that means an educational base."

--Scott Campbell, Vice President
NRM Petroleum Corporation
Dallas, Texas

"I'll be very blunt. You (Texans) have not got the education and university base to bring in high tech industry to replace oil. You're not investing in your future. You're taking your (oil) profits and running like a thief."

--Marvin Cetron, President, Forecasting International, and
Instructor, Massachusetts Institute of Technology

"The greatest obstacle (we face in Texas) is the inattention and inadequate financing for education. Every indication is that the critical resource for the industries of the future is a skilled work force, a well-developed human resource. Without paying balanced, coordinated attention to the educational challenge, the kinds of divisions that exist in Texas today threaten to become deeper and wider."

--Henry Cisneros, Mayor
San Antonio, Texas

"We are facing the greatest shortage of high-powered technologists that this country has ever known. I would state before a notary public that the need is going to get worse in the next decade than it was in the last. Texas will do better for a time (at attracting high technology), but if it doesn't cure this situation, it won't do better for a long time."

--Erik Jonsson, Former Chairman
Texas Instruments
Dallas, Texas

"The question is whether we can move into the technological industries of the 21st century. Agriculture will continue to be important. So will extracting (oil and gas) and manufacturing. But growth in all of these depends on our willingness to make an appropriate investment in research. We have a problem of misplaced priorities. Are we going to continue spending more money on the physical appearance of our institutions or are we going to begin to set as a higher priority the funding of research?"

--Kenneth Ashworth, Commissioner of Higher Education
Coordinating Board, Texas College and University System
Austin, Texas

COOPERATING SPONSORS AND EXHIBITORS
STATEWIDE CONFERENCE ON HIGH TECHNOLOGY

COOPERATING SPONSORS

Following are organizations and agencies who worked with the Advisory Council for Technical-Vocational Education in Texas and the Texas Education Agency in the sponsorship of the conference:

Texas Association of Post-Secondary Occupational Administrators

Texas Vocational Administrators and Supervisors Association

Texas Vocational Technical Association and Affiliates

Vocational-Technical Education Development Foundation

Texas Public Community/Junior College Association

Texas State Technical Institute System

Governor's Office of Volunteer Services

Texas Aerospace and National Defense Technology Development Council

Texas Association of Business

Texas Association of Private Schools

Texas Industrial Commission

Texas Industrial Development Council

Texas Employment Commission

Texas Research League

State Employment & Training Council

National Alliance of Business

Several individuals from firms, colleges, universities and school districts assisted in the planning of the conference.

EXHIBITORS

Computergraphics (Bausch & Lomb, Inc.)

Computer Aided Instruction (Control Data Corporation)

Modern Office (IBM)

Rehabilitation Engineering (Texas Commission for the Blind)

A very special thanks is extended to the companies and agency which provided very exciting displays of the latest in high technology.

ATTENDANCE
STATEWIDE CONFERENCE ON HIGH TECHNOLOGY

School District Educators (121)

General Administration	12
Vocational Administration/Supervision	93
Counselors	6
Teachers/Coordinators	10

Post-Secondary Educators (122)

General Administration	33
Occupational Administration/Supervision	58
Teachers/Coordinators	31

Other Educators (62)

Senior College/University Faculty	35
Texas Education Agency Staff	12
Education Service Center Personnel	4
Association Executives/Officers	11

Other Participants (92)

Members, Local Advisory Committees	47
State Advisory Council Members/Staff	21
Members, Local Boards of Education	4
Government Officials/Staff	5
Labor, Employment/Training Representatives	5
Not Otherwise Identified	10
Grand Total	397

There were five individuals, included in above totals, that were from outside Texas.

Conference Evaluation

Each attendee was asked to complete an evaluation form. Nearly 25 percent did so. All conference speakers were rated either "good" or "excellent." Over 85 percent rated the extent to which information gained will be useful as good or excellent.

Many attendees provided hand written comments. A typical comment was: "this has been one of the best organized, most informative, and best executed of any conference I have ever attended. Everyone on the program was outstanding. The opening slide show was good." Several participants felt additional high tech conferences are needed, with future conferences perhaps focusing on single high tech areas.

ABOUT THE COUNCIL

The Advisory Council for Technical-Vocational Education in Texas is a citizens advisory body with broad duties prescribed in some detail by state and federal laws. Key responsibilities are summarized on page 48 of this report.

The 25-member Council, established in 1969, is recommended by the Governor, appointed by the State Board for Vocational Education and confirmed by the State Senate.

Members, which serve three-year staggered terms, represent such diverse areas as business, labor, local school boards, employment and training institutions, correctional institutions, students, minorities, women, agriculture, and the public.

The Council was designated by the State Board of Education in 1973 to also serve as the State Advisory Committee for Adult Education.

The Council staff is comprised of: Alton D. Ice, Executive Director; Will Reece, Program Officer; Jeanine Hicks, Program Officer; Val Blaschke, Administrative Technician; and Lynda Permenter, Secretary.

1982-83 Council Membership
(Membership Categories in Parentheses)

1. *Robert D. Hunter,* Chairperson, Abilene (representing nonprofit private schools).

2. *Cletus G. Michel,* Vice Chairperson, El Paso (representing school system with large concentrations of persons with special academic, social, economic, cultural or language needs).

3. *Noe B. Calvillo,* McAllen, (knowledgeable about poor and disadvantaged persons).

4. *E. W. Collins,* Beaumont, (familiar with vocational needs and problems of management).

5. *Janie West Cotton,* Houston (familiar with vocational teacher training).

6. *James Currey,* Dallas (representing State Employment and Training Council).

7. *Jan Eisenhour,* Dallas (representing vocational-technical proprietary schools).

8. *Kimberly Gilliam,* Killeen (representing vocational students).

9. *Alejandro Hinojosa,* Harlingen (representing the general public).

10. *John Holcomb,* College Station (familiar with vocational needs and problems of agriculture).

11. *T. R. Jackson,* Houston (serving on local school board).

12. *Jacinto Juarez,* Laredo (representing community and junior colleges).

13. *Bobbie Kennedy,* Lufkin (current/recent recipient of adult basic education).

14. *Hortencia V. Lopez,* Port Lavaca (background in employment and training with knowledge of sex and job training descrimination and sex stereotyping).

15. *Hugh McCallick,* Edna (familiar with baccalaureate technical degree programs).

16. *James Martin,* Arlington (special knowledge of but not involved in administration of vocational education).

17. *Lane Murray,* Huntsville (representing state correctional institutions).

18. *Edith F. Patterson,* Houston (familiar with vocational education in comprehensive secondary schools).

19. *Donna Price,* Houston (familiar with vocational guidance and counseling).

20. *Richard Pulaski,* Lufkin (familiar with vocational needs and problems of labor).

21. *Dorothy R. Robinson,* Palestine (special knowledge of needs of physically and mentally handicapped persons).

22. *S. Don Rogers,* Austin (currently serving as a school superintendent).

23. *Milton J. Schiller,* Waco (actively engaged in technical training institutes).

24. *Gay Sweet-Harris,* San Antonio (representing vocational teachers).

25. *Jon Underwood,* Austin (representing state industrial and economic development agencies).

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